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ABSTRACT

This paper discusses several concepts and techniques from the areas of systems theory and economic analysis that can be used as tools in an effort to improve the productivity of the educational enterprise. Several studies investigating productivity in education are reviewed, and the analytical problems in conducting cost-effectiveness studies are explored. The paper points out the potential pitfalls in identifying, measuring, and comparing program costs, and addresses the difficulties inherent in assessing program outcomes. Several conceptual models designed for conducting cost-effectiveness studies in education are discussed and the results of a number of empirical investigations employing cost-effectiveness techniques are presented. The conceptual framework developed here views the education production process as a system consisting of four major components--system environment and controls, the school, outputs of schooling, and feedback. (Author/IRT)

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Theoretical Paper No. 68

ECONOMIC ANALYSIS OF EDUCATION: A CONCEPTUAL FRAMEWORK

by

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Report from the Project on
Organization for Instruction and
Administrative Arrangements

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ABSTRACT

Educational organizations and the learning process are extremely complex. This paper presents a conceptual framework for analyzing the complex relationships between school inputs and school outcomes and for conducting cost-effectiveness studies in education. The paper discusses several concepts and techniques from the areas of systems theory and economic analysis that can be used as tools in an effort to improve the productivity of the educational enterprise. In addition, the use of basic planning-programming-budgeting procedures is recommended to facilitate cost-effectiveness analyses.

Several studies investigating productivity in education are reviewed and the analytical problems in conducting cost-effectiveness studies are explored. The paper points out the potential pitfalls in identifying, measuring, and comparing program costs and addresses the difficulties inherent in assessing program outcomes. Several conceptual models designed for conducting cost-effectiveness studies in education are discussed and the results of a number of empirical investigations employing cost-effectiveness techniques are presented.

The conceptual framework developed in this paper views the education production process as a system consisting of four major components: (1) system environment and controls, (2) the school, (3) outputs of schooling, and (4) feedback. The first component includes socioeconomic variables that have been shown to influence school outcomes and the policy framework within which schools operate. The second component, the school system itself, includes two major elements: (1) school resource inputs--the human resources (students and professional staff) and the material resources (physical plant, classroom equipment, and curricular products), and (2) school resource applications--the manner in which school resources are combined or mixed to achieve designated objectives. The outputs of an educational system may be classified in several ways, e.g., short-range and long-range, cognitive and noncognitive, or monetary and nonmonetary. The fourth component is feedback based on evaluation of the system's outputs.

I

INTRODUCTION

In the past three decades, education expenditures have made up an ever larger component of the public budget, particularly at local and state government levels. The increase in expenditures by educational institutions has been particularly striking over the past 15 years. In 1975-76, for example, total expenditures by public and non-public educational institutions at all levels totaled $120 billion compared to a total of $24.7 billion in 1959-60. Total expenditures by public and non-public elementary and secondary schools increased from $18 billion to $75.1 billion in this same 15 year period. The increase in expenditures by institutions of higher education has been even more dramatic--from $6.7 billion in 1959-60 to $44.9 billion in 1975-76 (National Center for Educational Statistics, pp. 189-90).

Accompanying the growth in education expenditures has come an increasing concern for "accountability." As an enterprise involving the expenditure of public funds, accountability has always been a concern of educators from a fiduciary point of view, i.e., ensuring that public funds are not misappropriated, lost, or stolen. In recent years, however, the definition of accountability has broadened to encompass concern for achieving the most efficient use of the resources devoted to education. This concern is perhaps best expressed by the question, "Are we getting our money's worth from expenditures for education?"

Given the magnitude of expenditures for education, it is understandable that citizens and policy makers question the productivity of educational institutions and express concern for what they perceive as inefficiency in using resources devoted to education. Haggerty (1973, pp. 4-10) pointed out that in 1970 only four percent of American workers were engaged in agriculture, forestry, or fisheries as compared to 40 percent in 1890 and 20 percent in 1930. Yet the four percent in 1970 were producing substantially more food and forest products than the 40 percent in 1890. Based on these data, productivity per person engaged in agriculture increased more than ten-fold in that 80-year period. But on the other hand, Haggerty pointed out that between 1930 and 1970 our population increased by about 60 percent, our school enrollment increased by about 200 percent, and the number of persons employed in education increased more than 400 percent! Given these data, the interested citizen is likely to conclude that productivity in education decreased during the 40 years between 1930 and 1970 and that the quality of today's education may even have declined. This point of view is likely to be reinforced by widespread publicity currently given declining college board and other standardized test scores and the desultory results reported by the National Assessment of Educational Progress.

Clearly, the question of whether or not the resources allocated to education are being used efficiently is of great importance to society. The concern for achieving greater efficiency has been demonstrated over the past decade by the application of analytic techniques, such as planning-programming-budgeting, input-output analysis, cost-benefit analysis, and cost-effectiveness analysis, to educational problems. Unfortunately, too many analysts have sought simple answers to complex questions. They have frequently failed to recognize the extraordinary complexity of the processes involved in human learning. To attain greater efficiency and productivity, one must be able to specify the resources needed, the quantity, and the combination, to produce a desired level of knowledge, skill, or behavior. Educators are confronted with these kinds of questions: Do differences in the kind and amount of resources lead consistently to different educational outcomes? What school characteristics, configurations, and programs lead to differences in outcomes? What impact do schools have on students? Because schools are not ideal laboratories in which organizational features (such as the distribution and utilization of resources, composition of the student body, placement of students in programs, methods of instruction and evaluation, or operational objectives of school programs can be manipulated), adequate research evidence is difficult to obtain. Despite these difficulties, however, educators must ask whether the resources at their disposal are being effectively and efficiently allocated and utilized.

We do not propose in this paper to identify quick and easy ways to improve productivity and efficiency in the use of resources devoted to schooling. We are primarily concerned with developing a conceptual framework to facilitate analysis of the complex relationships between school resources, school processes, and school outcomes. Application of systems analysis and economic analysis will be discussed, selected literature bearing upon productivity and efficiency in education will be reviewed, and a conceptual schema designed to guide the search for connections between school resources, school processes, and school outcomes will be formulated.

II

EDUCATION AND SYSTEMS ANALYSIS

The concept of a system is not a recent one and the word "system" has many definitions. Kershaw and McKean (1959, p. 2), in their pioneering work applying systems analysis to education, defined a system as "a set of interrelated factors that are used together to produce an output." Martin (1969, p. 49) defined a system as "an assemblage or combination of things or parts forming a complex whole." He noted that one of the most important characteristics of a system is that it is composed of a hierarchy of subsystems. Banghart (1969, p. 26) defined a system as "an integrated assembly of interacting elements, designed to carry out cooperatively a predetermined function." These definitions are similar. Each conveys the notion that a system is complex, that it is composed of several elements, that its elements are interactive, and that the elements and their interaction are purposive. Under any of these definitions, a classroom, a school, a school district, all of the school districts in a state, or all of the school districts in the nation qualify as systems.

Although the study of systems is not new, the emergence of systems analysis as a specialized discipline is relatively recent. Systems analysis is concerned with the careful, disciplined study of systems to identify feasible, efficient, and acceptable means for accomplishing a given purpose. As Hare (1967, p. 2) has pointed out:

> To understand and improve . . . systems by utilizing the relationships that result when diverse components are combined, investigators must be able to follow and exploit the chain of work flow, information flow or material flow--the connecting links that tie the systems together. And, these connecting links almost always lead across the boundaries of educational discipline and organizational function.

Systems analysis may be described as a comparison of alternative means of carrying out a function when the means are complicated and include a number of interrelated elements. Before a system can be analyzed, a model of that system must be conceived. A system model has been described as "a wide-angled lens trained on an organism so that it can be seen in its entirety, including the relationships among its (component) parts and between the organism and the environment [Coombs, 1968, p. 8]."

The model of a system provides the conceptual base for analysis of that system. It must represent as accurately as possible the activities associated with the system and their interrelationships. Such a model typically will

include "a set of inputs, which are subject to a process, designed to attain certain outputs, which are intended to satisfy the system's objectives [Coombs, 1968, p. 9]." A curricular innovation in education, for example, may entail significant changes in instructional methods which, in turn, require changes in the utilization of time, physical facilities and equipment required, and the number and kind of personnel needed. Alterations such as these have consequences for the system's input requirements, for the nature of the process employed, and for the quantity and quality of the system's outputs.

Kershaw and McKean (1959), in their work for the Rand Corporation, proposed applying systems analysis techniques to assess the possibility of making quantitative comparisons of educational systems. They stressed the need for conceptual development of models and/or relationships required to estimate all costs, alternative processes, and output measures needed for analysis of educational systems. They discussed the difficulties involved in measuring educational output, proposed a procedure for estimating incremental costs and output from new systems, and suggested a method for interfacing cost and output data to compare systems. Although various applications of systems analysis techniques in education could be cited, perhaps the best known have been those associated with attempts to develop program planning and budgeting systems for educational organizations.

III

EDUCATION AND ECONOMIC ANALYSIS

Economics deals with the allocation and utilization of scarce resources, i.e., resources for which there exist alternative uses. The economist seeks to allocate these scarce resources among alternative uses in a manner which maximizes the satisfactions gained by consumers. For the economist, maximum efficiency is achieved by utilizing resources in such ways that any change in their allocation among alternative uses would reduce the total satisfaction of consumers. Since the resources allocated to education by society could be devoted to many other uses, the most efficient use of these resources is a legitimate concern of both economists and educators.

EDUCATION AS AN ECONOMIC GOOD

Although Adam Smith and other early writers suggested links between education and economics, it is only in recent years that economists have devoted serious attention to education. The growing interest in the economic aspects of education can be attributed to recognition that (1) education is one of our largest enterprises and a major employer of skilled personnel, (2) education may influence significantly an individual's employment and income opportunities and thus affect the distribution of income and wealth in society, and (3) education, as the primary provider of trained and skilled personnel, is an important factor in economic growth and development (O'Donoghue, 1971).

The U.S. economy is often referred to as a "market economy" in which the flow of goods and services is regulated by the demand for them. The term demand, as used in economics, refers to a functional relationship between the price of specific goods or services and the amount of those goods or services which will be purchased. Demand is a subjective concept only to the extent that it measures the relative value consumers place upon given goods or services in comparison with other goods or services that they could buy. The demand for most goods and services provided through the operation of the market can be measured objectively and quantified with precision. As the price of specific goods or services increases (assuming the demand for it is elastic), the amount purchased will generally decrease because other goods and services will become more attractive to the consumer. Thus, when the market is operating freely (unconstrained by monopoly, regulations, etc.), the flow of goods and services is regulated in a manner which reflects the relative demand for those goods.

The component of the total economy in which the market serves to allocate goods and services in accordance with the relative supply and demand for them is generally referred to as the private sector. Although the private sector makes up the largest portion of our economy, a significant amount of goods and services is provided by agencies of government, i.e., the public sector of the economy. The supply of most goods and services provided through the public sector--highways, national defense, police and fire protection, education, for example--is determined by legislative and/or administrative judgment with regard to the amount of a given good or service that should be provided to best serve the general welfare of society. In the public sector, the judgments of public officials (based upon their perception of "needs" rather than the operation of the market) determine the kind and amount of goods and services made available to consumers.

One of the serious problems encountered in a "pure" market economy is that individual consumers invariably act only in their own self-interest, which is not always the best interest of the total society. Application of the concept of need enables public officials to decide upon the kind and amount of services, such as education, national defense, police and fire protection, and highways, which they believe will best serve the general public. Society's need for educational services for handicapped children, for example, may be far greater than the private demand for such service as reflected by the market. Because educational services for handicapped children often are very expensive, the parents of handicapped children frequently are not in a financial position to buy the services. Public officials, however, may decide that the general welfare of society will best be served by appropriating public funds to provide special education services for handicapped children. In this way the concept of need rather than the concept of demand is employed to determine the level of goods and services provided through the public sector of the economy.

EDUCATION AS A MERIT GOOD

Musgrave (1959, pp. 6-15) distinguished between two classes of goods which typically are provided through the economy's public sector--social goods and merit goods. He defines social goods as those which by their very nature cannot be supplied effectively by the market because they are equally available to all persons whether or not they pay for them. National defense and the judicial system are examples of social goods. Merit goods are defined as those goods which could be provided through the market but are thought to be so important to society that their provision cannot be left entirely to the unenlightened self-interest of individual consumers. Education is a prime example of a merit good. The maintenance of an educational system in which all citizens have free access to at least a minimum level of education is thought to be vital to democratic self-government. Therefore, education is provided primarily through the public sector and financed primarily through the public budget.

Another reason exists for financing education through the public sector. While education yields direct benefits to students and their families (as in increased earning potential), it is also believed to yield benefits to the community and to society at large (for example in the form of increased productivity and lower welfare costs). Benefits that accrue directly to students

are termed internal or private benefits; those that accrue to others in society are termed external or social benefits. Externalities (external costs or benefits) arise when goods or services either confer benefits or impose costs on persons other than the consumer or the producer. Education is generally thought to be characterized by substantial externalities because it affects so many people who do not buy it directly.

The importance of external benefits lies in the fact that private decisions concerning whether or not to purchase education will be evaluated almost entirely on the basis of internal benefits, those benefits gained directly by students or their families. If education were supplied only through the private sector, the decision to invest in education would be based solely on the anticipated direct benefits to the student and would disregard any external benefits which may be realized by society.

While it is difficult to place a precise value on the social benefits associated with education, they are not insignificant. The social benefits of education include greater flexibility and adaptability of the labor force which, in turn, enhance our capability to develop and apply technological improvements. Education is a major instrument promoting equality of opportunity in society and is generally recognized as a requisite for successful democratic self-government. Negative externalities, such as higher unemployment and crime rates, may result from lack of education.

The external benefits associated with education provide a persuasive case for public support of education. As we have noted, externalities are not considered in private investment decisions and, because they are ignored, the optimal allocation of resources to education by society would not be achieved if education were provided only through the private sector. Public financing of education, then, provides a mechanism for giving due consideration to education's external benefits in the process of allocating resources.

It should be emphasized that there is no economic reason why education could not be supplied entirely through the private sector. Consumers (households) could purchase education from privately operated schools just as they now purchase many other goods and services. However, the amount of education which would be purchased in the market by households probably would be considerably less than optimal in terms of the general welfare of society. Thus, in the United States we have chosen to finance education primarily through the public budget. The difference between what consumers (households) would spend for education if it could be purchased only in the market at full cost and the total amount of money expended for education in the private and public sectors combined may be viewed as a form of public subsidy. The purpose of this subsidy is to ensure that at least a minimal level of educational opportunity is provided to all children.

It is important to note that in the private sector the supply of goods or services is determined by the market which, at least theoretically, will serve to "weed out" inefficient producers, i.e., those whose cost of production exceeds the going price of the goods or services. In the public sector, on the other hand, supply is determined by the operation of a political decision-making process, not by the operation of the market. Thus, in the public sector, there is no mechanism to ensure that goods and services are provided in the most efficient possible manner. The lack of a mechanism to automatically "weed out" inefficient programs undoubtedly is one reason for the growing interest in the evaluation of programs in the public sector.

EDUCATION AND THE CONCEPT OF HUMAN CAPITAL

The concept of human capital is based on the idea that the skills and knowledge possessed by people are, in fact, resources and that these resources represent a very important part of the stock of capital available to society. From an economic viewpoint, capital is characterized by its ability to generate future satisfactions, future earnings, or both. Education qualifies for consideration as capital just as land, industrial plants, or coal mines do because education has the ability to generate future satisfaction and future income. Viewed in this way, the economic value of education can be expressed as a function of the income stream that a given level of education is able to generate.

When education is viewed as a form of capital, decisions with respect to education, whether made by a student, a household, or public or private agencies, are dealt with as investment decisions and are based on the relative rates of return available to alternative investment opportunities. Education is viewed as one component in the total stock of capital. Investment decisions about education follow the rules which guide other investment decisions. Thus, additional investment in education occurs only if the rate of return from the investment equals or exceeds the rate of return available from alternative investments.[1]

Economists have developed a number of analytic tools to evaluate alternative investment opportunities. Although these tools were devised to evaluate alternative investments in physical capital, they also can be applied to analyze costs and benefits associated with human capital. Two of the primary procedures used are present value analysis and analysis of internal rate of return.

PRESENT VALUE ANALYSIS

The costs of obtaining education are incurred over one period of time; the financial benefits which accrue as a result of that education are derived over another period of time. To facilitate comparison of a stream of investment and a stream of income, it is useful to reduce both streams to a base year value. This is the basis for present value analysis. As Thomas (1971, p. 22) noted:

> Present value analysis consists of using compound interest and compound discount procedures to reduce a stream of cost and a stream of income to their value at a given base year. A dollar received today could be invested to yield interest; if that interest is allowed to accumulate, today's dollar will increase at a compound rate of interest. But this also implies that a guaranteed payment of one dollar in ten years time is equivalent to a smaller amount of money today.

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[1] For further explication of this topic see Schultz, 1970, pp. 29-57.

If the rate of interest is i, the present value of one dollar to be received ten years in the future can be expressed by the formula $\frac{1}{(1+i)^{10}}$. Generalizing, the present value of an income stream of Y dollars per year for n years beginning with year t can be expressed by the formula:

$$Vo(Y) = \sum_{t=1}^{t=n} \frac{Yt}{(1+i)^t}$$

Similarly, the present value of a stream of cost in the amount of X dollars per year can be expressed by the equation:

$$Vo(X) = \sum_{t=1}^{t=n} \frac{Xt}{(1+i)^t}$$

Using this approach, investment in education occurs if the present value of the additional benefits associated with an increment of education is greater than the present value of the additional cost incurred in obtaining that increment. Thus, an investment would be undertaken if

$$Vo(Y)-Vo(X) = \sum_{t=1}^{t=n} \frac{Yt}{(1+i)^t} - \sum_{t=1}^{t=n} \frac{Xt}{(1+i)^t} > 0.$$

Obviously, the choice of the discount rate to be applied is critical in determining whether or not additional investment in education should be undertaken. The choice of the appropriate discount rate is essentially a subjective decision. If the desire is to receive income as soon as possible, a high discount rate will be utilized, thus reducing the present value of a future income stream. If, on the other hand, one is willing to defer receipt of income, a lower discount rate will be used, thus increasing the present value of a future income stream. In determining the appropriate discount rate, such factors as the time preference of the individual, rates of return available on other investments, and the interest rate one must pay on borrowed funds are considered.

RATE OF RETURN ANALYSIS

The internal rate of return is that rate which equates the present value of the investment to zero, as shown by the following equation:

$$Vo(Y)-Vo(X) = \sum_{t=1}^{t=n} \frac{Yt}{(1+i)^t} - \sum_{t=1}^{t=n} \frac{Xt}{(1+i)^t} = 0.$$

As stated by Thomas (1971, p. 24), "The decision rule is that individuals (or social groups) should continue to invest as long as the rate of return exceeds that obtainable from other alternatives which are considered."

Present value analysis and rate of return analysis can provide useful information to policy-makers concerning macro-level policy decisions. That is, it is possible to evaluate returns to additional investments in education compared with returns to additional investments in other areas, such as public health, highways, or flood control. Information obtained from present value or rate of return analysis can also be of use to individuals considering whether they should invest in additional increments of education in comparison with other investment opportunities.

These techniques do not, however, provide guidance or direction with regard to questions concerning how to most efficiently use resources allocated to education. That is, they are not particularly useful in micro-economic analyses dealing with the question of how to maximize productivity of resources devoted to education once a level of investment has been determined.

EFFICIENCY AND PRODUCTIVITY IN EDUCATION

In the remainder of this paper we shall be concerned with the broad issue of optimization. That is, how can the resources allocated to education by society be most efficiently used? We assume that the level of public investment in education will continue to be determined through the political decision-making process. We also assume that individuals will continue to make their own decisions with regard to whether or not they will invest in additional increments of education. Thus, the level of resources available for education will be a function of both public and private decisions. Given any established level of investment, the question confronting educators is how to use available resources most efficiently, i.e., how to maximize the desired outputs of the educational process from a given level of resource input.

Although input-output, cost-benefit, and cost-effectiveness analyses have been undertaken in the field of education, the studies in which these tools have been employed generally have utilized data aggregated at a relatively high organizational level, such as a school system, a state, or even the nation. We shall be particularly interested in examining the application of these tools in dealing with questions of sub-optimization. That is, we are interested in the possibility of using more discrete units of analysis in an attempt to deal with questions concerning the most efficient resource allocation for individual schools or groups of students possessing specified characteristics. We are concerned that despite widespread recognition that each student is a unique individual, previous analyses have treated students as if they were interchangeable units. We also are concerned that the practice of aggregating data at a school district level inevitably destroys the richness of detail and variability observed when individual students are the basis for analysis. We believe that focusing upon sub-optimization in the use of resources holds greater promise in providing useful information to school level decision makers. In fact, we are inclined to believe that full optimization in the utilization of resources allocated to education can only be achieved through successive approximations based on sub-optimization of productivity at specific educational levels or for specific target groups.

IV

SCHOOL PRODUCTIVITY--RELATED RESEARCH FINDINGS

Numerous studies of school productivity and effectiveness have been conducted over the past fifty years. The initial "cost-quality studies" conducted by Mort and others examined gross relationships between aggregate levels of educational expenditures and various measures of school processes and outcomes (Mort, Reusser, and Polley, 1960). While these early studies consistently demonstrated that high expenditure schools were more effective than low expenditure schools in terms of the criterion variables employed, they did not reveal which school inputs have the greatest impact on student learning or even which resources make a difference. In short, the studies provided little, if any, direction with regard to how to allocate available school resources effectively and efficiently.

Over the last two decades a variety of measures assumed to represent proxies for inputs to educational processes have been used in an attempt to determine school effectiveness. In one of the first input-output analyses, Mollenkopf and Melville (1956) surveyed a sample of approximately 9,500 ninth grade students in 100 schools and 8,400 twelfth grade students in 106 schools. The researchers used questionnaires completed by school principals to develop an initial list of 34 independent measures, including variables such as the nature of school facilities, the degree level of the principal, the number of special staff, the pupil/teacher ratio, a drop-out index, and the average teacher salary. Student scores on seven different aptitude and achievement tests were used as dependent measures. Attempting to control statistically for socioeconomic factors (such as occupation of father, size of community, and percentage of support from state aid) and employing stepwise multiple regression techniques, the authors obtained significant relationships between their measures of student achievement and (1) per pupil instructional expenditures, (2) number of special staff, e.g., school psychologist, reading specialist, and guidance counselor, (3) average class size, (4) pupil/teacher ratio, and (5) percentage of the school's graduates entering college.

Three years later Goodman (1959) conducted the Quality Measurement Project (QMP) which analyzed a sample of 70,000 seventh and eleventh grade students drawn from 102 school districts in New York State. After controlling for socioeconomic factors, Goodman found a significant relationship between the achievement of seventh grade students and (1) per pupil instructional expenditures and (2) number of special staff per 1,000 students. At the same time, two additional factors were linked to student performance--teacher experience (number of teachers in a district with five or more years as classroom instructor) and "classroom atmosphere" (an observational rating attempting to measure the degree to which a teacher was student oriented). Reinforcing the findings of the earlier Mollenkopf-Melville work, the QMP study also suggested that certain attributes of school personnel are likely to play an important role in the learning process.

Thomas (1962) utilized Project TALENT information[2] and 1960 census data to examine the impact of a large number of home, school, and community variables on student achievement. Thomas' sample consisted of tenth and twelfth grade students from 206 high schools in communities with populations between 2,500 and 25,000. The schools were scattered among 46 states. Using stepwise multiple regression techniques, he found statistically significant relationships between student achievement and (1) beginning teacher salaries, (2) teacher experience, and (3) number of volumes in the school library.

Benson (1965) conducted an extensive study of California's public schools in 1964. Data were obtained from the 1960 census as well as from statewide and school district records to study a sample of fifth grade students in 249 school districts. The sample was divided into three groups based on district size (number of students in average daily attendance). Benson reported that teacher salaries and per pupil instructional expenditures were significantly related to student achievement (as reflected by test scores in reading and mathematics). In addition, Benson found that in the middle-sized districts (2,000 to 4,500 pupils), the salaries of administrators were associated positively with student achievement.

At the same time that Benson was conducting his study in California, Kiesling (1967) was re-examining data collected earlier in the New York QMP study. As in the Benson study, the QMP work utilized data aggregated by school districts rather than individual schools as the unit of analysis. Kiesling also found that per pupil expenditures were associated positively with student performance. The relationship was quite strong in urban school districts but weak in rural school districts. Kiesling observed that an additional expenditure of $100 was associated with 2.6 months of achievement gain at the low end of the expenditure range and with 1.4 months at the high end of the range. In addition, Kiesling found that school district size and student performance were not related.

The Equality of Educational Opportunity (EEO) study, popularly known as the Coleman Report (Coleman, 1966), was the first large-scale input-output survey of the nation's schools. This landmark study surveyed 645,000 students at various grade levels in 3,100 schools. Input measures consisted of 93 variables grouped into four major blocks--home background factors, teacher characteristics, student-body variables, and school facility and curriculum measures. Scores on standardized achievement tests served as output measures.

The research by Coleman and his colleagues highlighted the significance of the relationship between socioeconomic milieu of the school and student performance. Home background factors were clearly the most important group of variables explaining variance in achievement levels for all four major subgroups of students--southern and northern blacks and southern and northern whites. Student-body characteristics, e.g., plans to attend college, school attendance, and racial composition, were the second most important group of variables explaining variance, particularly in the achievement of minority students. Of the school-related variables, none of which accounted for a

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[2]Project TALENT surveyed a nationwide sample of approximately 300,000 students in almost 1,000 high schools in 1960. These students provided detailed information about themselves and also completed aptitude, ability, achievement, and interest tests. For additional information regarding this national data bank, see Flanagan, Davis, Dailey, Shaycoft, Orr, Goldberg, and Neyman, 1964, and Shaycoft, 1967.

large amount of variation in achievement, teacher characteristics had the greatest impact, once again affecting minority students most.

To say that these findings generated considerable controversy would be an understatement. Many researchers were unwilling to accept the proposition that school resources had little or no effect on academic achievement. Critics of Coleman's work suggested that the relationship between school resources and academic achievement had been substantially understated because of defective measurement of school resources, inadequate control for social background, and inappropriate statistical techniques.[3] The quality of the Coleman data was questioned, particularly because of the apparently high correlation between family background factors and school resources. Because of this joint variance, the explanatory power of school variables was drastically reduced simply because environmental variables were entered into the regression first.

A number of researchers have re-analyzed the EEO data and, although hampered by limitations of the original data, have been able to clarify some of the problems involved in applying the production function concept to the learning process. In one of the first re-analyses, Hanushek (1968) developed a conceptual model to estimate educational production functions for black and white sixth graders in northern metropolitan schools. The results of Hanushek's estimations disclosed that teacher characteristics, such as verbal ability and years of experience, were significantly related to student achievement. This finding was of particular interest since the Coleman data on school variables permitted an investigation of interschool variance in achievement only and not intraschool variance which was considerably larger.

Bowles (1970) presented a comprehensive treatment of educational production functions in his re-analysis of a subset of the Coleman data consisting of twelfth grade black male students. Bowles' work reaffirmed the importance of teacher characteristics and suggested that certain other school inputs were important. These other school factors included the average amount of time a teacher spent in guidance activities and the number of days a school was in session during the school year. Bowles argued that student characteristics such as attitude and motivation can be viewed as either inputs to or outputs of the learning process. He then developed a model involving the solution of a set of simultaneous equations to determine the relative effects of the related variables.

Also utilizing the EEO data, Levin (1970a) examined a sample of 600 white sixth grade students drawn from 36 schools in a large northeastern city. Levin obtained statistically significant relationships between student achievement, teacher experience, and quality of undergraduate institutions attended by teachers. Levin also pointed out that some factors affecting student achievement are at the same time affected by achievement. To investigate this interactive process, Levin developed a conceptual model to illustrate the interdependence of student achievement, student motivation, student efficacy, and parental attitudes. He also presented a methodology for solving the complex system of simultaneous equations that differs from the technique employed by Bowles.

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[3]See, for example, Bowles and Levin, 1968a, pp. 3-24. Also see Bowles and Levin, 1968b, pp. 393-400. For a comprehensive critique of the Coleman Report, see Mosteller and Moynihan, 1972.

Burkhead and his colleagues (1967) examined input-output relationships in public secondary schools of two large-city systems. Their sample included 39 Chicago schools enrolling approximately 90,000 students and 22 Atlanta schools enrolling about 19,000 students. The researchers used data obtained from the 1960 census and from the two school districts to conduct separate analyses for each city. In addition, they compared the major findings in these two cities with a sample of 177 public high schools located in smaller communities. Information on these latter schools was drawn from the Project TALENT data bank.

Similar (but not identical) independent and dependent measures were used for each of the three subsamples. The authors considered the impact of variables such as median family income, average daily attendance (ADA), age of school building, teacher experience, and per pupil expenditure on school outputs such as achievement scores, number of dropouts, and students' post-high school intentions. In Chicago, higher family income levels and newer school buildings were associated with lower dropout rates. Family income was also found to be associated with IQ and reading scores. Of the school variables, only teacher experience was related to student reading scores. For the Atlanta schools, family income was again related to dropout rate and achievement scores. In addition, a low rate of teacher turnover was positively associated with higher test scores. For the high schools in smaller communities, the authors reported a relationship between reading scores and (1) family income, (2) age of school building, (3) teacher experience, and (4) beginning teacher salary.

Several input-output studies in individual states or school districts were published in 1968. Katzman (1968) used cross-sectional data from 56 elementary schools in Boston to examine the importance of home background factors and school variables in explaining change in student achievement between second and sixth grade. Using a stepwise multiple regression technique, statistically significant relationships were obtained between gains in reading scores and the percentage of students in noncrowded classrooms, the number of students in the attendance area, and the percentage of teachers with 1-10 years of teaching experience. In addition to providing further evidence that teachers affect pupil performance, Katzman also pioneered the use of several measures of school output in his study, including such noncognitive outcome indicators as school "holding power" and student "aspirations."

Cohn (1968) investigated input-output relationships in 377 public high school districts in Iowa. He utilized data from the Iowa State Department of Public Instruction to examine possible economies of scale in school district operations. An attempt was made to control statistically for geographic and population differences with a set of eight school district variables serving as the input measure. The output measure was based on the gain in student achievement scores between tenth and twelfth grades. Employing multiple regression techniques, Cohn found that higher teacher salaries and fewer different teaching assignments were associated with larger growth increments in test scores. Cohn also estimated the optimal school size for Iowa to be about 1,500 students in ADA.

In a similar study, Raymond (1968) examined the quality of schooling in West Virginia. Raymond's sample consisted of approximately 5,000 students who entered West Virginia University between 1963 and 1966. These students represented 49 county school districts in West Virginia. The inputs included

five population characteristics, four school variables, and six teacher salary variables. Output measures consisted of freshman grade point averages and American College Test scores. After grouping students by counties, Raymond obtained a significant relationship between a student's freshman performance and teacher salaries. Raymond further reported that the average salary for elementary teachers appeared to have a stronger effect on student performance than did the average salary for secondary teachers.

Ribich (1968) also conducted a study using data from several sources, including Project TALENT. The researcher examined the relationship between expenditures per pupil and the achievement levels of approximately 6,300 twelfth grade male students who ranked in the lowest quintile on measures of socioeconomic status. The effect of increases in school expenditures on test performance was greatest at the lower end of the expenditure range. Ribich (1968, p. 87) observed that, "The apparent power of increased expenditures to improve performance diminishes progressively with each successive expenditure level."

The following year, Kiesling (1969) investigated the relationship of school inputs to school performance in 97 school districts in New York State. Kiesling utilized school district records to compile the necessary school resource and family background data. A set of 17 independent variables included teacher/pupil ratio, median teacher salary, ADA, and school property valuations per pupil. The dependent measure consisted of sixth grade achievement test scores. The sample was divided into five subgroups based on the family "breadwinner's" occupation. School districts were divided into urban and nonurban categories. The occupation index was significantly related to student achievement for all subgroups in both the urban and nonurban categories. Most of the associations between achievement and per pupil expenditures in the urban districts were negative. Per pupil expenditures did not appear to have a significant effect in the nonurban districts.

In another study Kiesling (1970) investigated the relationship of several school and community characteristics to student achievement in a sample of fifth and eighth grade pupils in 86 school districts in New York State. School data were obtained from the Basic Educational Data System (BEDS) which was established in New York in 1967 to collect detailed information on the state's school system. The variables utilized and the analyses conducted were similar to those employed in his previous study. Kiesling reported that the amount of school resources devoted to central administration and supervision was most consistently related to pupil achievement. In addition, the level of teacher certification, especially at the fifth grade level, and the number of students per classroom were also related positively to student achievement.

Guthrie and his colleagues (1971) conducted a study in Michigan in which they examined three research propositions involving the relationships between (1) socioeconomic status of pupils and school services, (2) school services and pupil achievement, and (3) pupil achievement and post-school opportunity. These researchers relied upon the "Thomas Report" (Thomas, 1968) as their primary source of information. A random sample consisting of 52 unified school districts plus the Detroit School District was drawn. This sample was supplemented with information collected in 14 Michigan school districts for the EEO study in 1966. Data from the Thomas study were used to make comparisons of school quality between school districts. EEO data were used to make comparisons between individual schools.

The independent measures included four related to school facilities, one related to instructional materials, five related to teacher characteristics, and four related to student characteristics. Measures of pupil performance included pupil test scores of reading ability, mathematics understanding, and verbal facility. To control for socioeconomic status (SES), the researchers divided the 5,284 sixth grade students into 10 subgroups based on occupation-education index scores. They then calculated a rank order correlation coefficient between the school input variables and student test scores within each SES decile. Several variables, including building age, library volumes per student, school enrollment, classrooms per 1,000 students, teacher attitudes, and teacher verbal ability, were related at a statistically significant level for at least half of the socioeconomic groups and the verbal test scores.

All of these researchers were confronted with difficult methodological problems. In addition to the problems involved in satisfying the assumptions underlying the production function itself, the complexity of the school setting and the learning process further complicate any research effort. First, the natural school setting itself presents formidable obstacles. Unlike the controlled laboratory experiment, the school setting does not give researchers an opportunity to carefully control and manipulate variables to determine the relative impact of specific inputs. Students, for example, rarely can be randomly assigned to different school treatments. Differences in classroom conditions, a diversity of teaching styles, teacher turnover, student mobility, and the like serve to confound any analysis.

Second, the absence of a well-developed theory of learning greatly complicates the research task. The specification of a production function for the learning process--the relationships between the identified educational inputs and outputs--must therefore be based largely on intuition. To illustrate the problems involved, Luecke and McGinn (1975) specified several sets of causal relationships between and among several types of input variables--family, school, and teachers. The authors used a computer simulation model to generate data sets characteristic of those relied upon in the previously described studies. They then examined the results obtained using different kinds of aggregation procedures and regression analyses. They concluded that, because of the complexity of the interactions, they were unable to obtain consistently reliable estimates of the predetermined causal relationships, i.e., those relationships built into the data sets. Thus, they suggested that some of the "no significant effect" findings which have been reported might be a product of the statistical techniques employed.

Third, most researchers have been hampered by the lack of disaggregated data. When measures of central tendency, e.g., school or system averages, are used as measures of input or output, the true impact of specific school resources is nearly always disguised. If, for example, experienced teachers are effective with high ability students but ineffective with low ability students, an analysis based on mean scores is likely to disclose no effect. Data on individual students and teachers within the same classrooms and schools are badly needed.

Recent studies in Philadelphia and New Haven have attempted to overcome some of the problems inherent in the use of aggregated data. Summers and Wolfe (1975) conducted an in-depth analysis in the Philadelphia public school system using longitudinal data to study the academic progress of approximately 2,000 students at various grade levels in 150 different schools. Data were related to

the achievement growth of individual pupils between the end of the third and the sixth grades, the sixth and eighth grades, and the ninth and twelfth grades. Socioeconomic factors and specific school resources were carefully tied to data on individual pupils.

Based on multiple regression analyses of the data at each level of schooling examined, the authors concluded that school inputs, such as teachers and class size, and school climate variables, such as racial composition, achievement mixture, and disruptive incidences, did influence student achievement. All types of students (black, white, low achievers, and high achievers) at all grade levels scored higher in achievement the more days they attended school. Likewise, all types of elementary students learned more in schools in which 40 to 60 percent of the student body was black and in schools with a larger percentage of high achievers. Elementary school students also did better in smaller classes and with teachers who were graduates of higher-rated colleges. Junior high school students learned more in schools which were part of an elementary school and in schools in which there were more high achievers. These students also did better with teachers who graduated from higher-rated colleges and with mathematics teachers who were trained in the post-Sputnik, new math era. In general, senior high school students displayed greater achievement in smaller schools and in schools with fewer dropouts.

In addition, Summers and Wolfe found that specific types of students can be helped even more if particular types of resources are targeted to them. Black students, for example, appeared to do better in the smaller elementary schools and in junior high schools with larger black populations. Low-achieving elementary students did better with relatively less experienced teachers, in smaller classes, and in schools with more high achievers. Low-achieving junior high students did better with relatively less experienced English teachers and in schools with more high achievers. High achievers, however, did better with more experienced teachers.

Murnane (1975) conducted an input-output analysis to investigate the impact of school resources, especially teachers, on the cognitive achievement of inner-city children in New Haven, Connecticut. The sample consisted of 875 black children in 15 elementary schools. Data were available over a two-year period (second and third grades) for one group of children and over a one-year period (third grade) for another group. The data base was divided into three subgroups. Each subgroup was followed over the period of one school year. As in the Philadelphia study, the students in the sample were systematically matched with individual census blocks.

After examining the effect of the classroom as a whole on the achievement of children, Murnane concluded that there are important differences in the amount of learning that occurs in different classrooms within the same school and among different schools. The effects of several classroom-related variables, such as teacher, peer group, and student turnover, were carefully considered. After determining that teachers exerted a critical impact on student achievement, Murnane explored the relationship between specific teacher characteristics and teacher effectiveness in math and reading instruction with certain types of pupils.

Based on the results gained by regression analysis techniques, Murnane reported that background factors and previous experiences had a greater influence upon student reading achievement than upon math achievement. Differences in the quality of classroom environments were found to exert a greater effect on

student math achievement than on reading achievement. Murnane also found that black teachers with less than six years of experience were more effective in teaching reading to black children than were white teachers with similar teaching experience. At the same time, a high rate of student turnover in a class was found to have an adverse effect on children's reading achievement, particularly on the progress of high achievers.

By using disaggregated data, both of these studies revealed important findings. Many school resources affect different types of students in different ways; few school resources consistently effect all students equally. Clearly, an important aspect of the educational process is the unique interaction that takes place between certain types of school resources and certain types of students. Low achieving students, for example, appear to learn more with relatively inexperienced teachers while high achieving students seem to learn more with experienced teachers. Small classes apparently help low achievers but are not particularly important for average or high achievers. Only research which focuses on individual students within specific instructional settings can offer insights into these extremely complex interactive relationships.

V

PLANNING-PROGRAMMING-BUDGETING SYSTEMS

As discussed previously, the systems approach has been used in the quest for efficiency and productivity in educational organizations. A well-conceived planning-programming-budgeting system (PPBS) may be viewed as an operational application of systems analysis. In general, a PPBS would include as a minimum the following procedures: (1) specifying the objectives, (2) identifying alternative programs to achieve the specified objectives, (3) estimating as accurately as possible the costs and benefits associated with each of the alternative courses of action, (4) selecting one or more programs to implement, (5) monitoring the implemented programs and evaluating progress toward attainment of specified objectives, and (6) feeding back the results of the evaluation to modify the program and increase its efficiency.

PPBS stresses strategic planning and the role of analysis in the budgeting process. Fisher (1971a), one of the first writers on PPBS, summarized the most salient characteristics of PPBS under three basic headings:

1. The structural aspects of program budgeting are concerned with establishing a set of categories oriented primarily toward "end product" or "end objective" activities that are meaningful from a long-range planning point of view. In such a context, emphasis is placed on provision for an extended time horizon--some five or even ten or more years into the future.

2. Analytical process considerations pertain to various study activities conducted as an integral part of the program-budgeting process. The primary objective of this type of analytical effort is to systematically examine alternative courses of action in terms of utility and cost, with a view to clarifying the relevant choices (and their implications) open to the decision makers in a certain problem area.

3. Information system considerations are aimed at support of the first two items. There are several senses in which this is important, the primary ones being (1) progress reporting and control and (2) providing data and information to serve as a basis for the analytical process--especially to facilitate the development of estimating relationships that will permit making estimates of benefits and costs of alternative future courses of action.

While emphasizing the planning function and the systematic evaluation of alternative programs, PPBS also accommodates the other major budgeting functions of financial and managerial control. Budgeting systems at federal, state, and local governmental levels have always consisted of these three basic functions but each has been emphasized to a different degree throughout the last 50 years.

Schnick (1971) described three successive stages of budgetary reform at the federal level in the United States. The first stage began around 1920 with the Budget and Accounting Act of 1921. Throughout the 1920s the budget was viewed basically as an instrument for controlling organizational spending and curbing administrative abuses. Changes in budgeting practices therefore were primarily concerned with development of a reliable system of expenditure control. Characterized by an input orientation, the typical budgeting structure during this period systematically detailed the "objects" of expenditures. This object-of-expenditure classification scheme, generally called a "line-item" budget, simply provided a listing of the expense objects, such as salaries, supplies, and equipment.

The second stage of budget reform, according to Schnick, extended from the mid-1930s to about 1960 and was associated with the rapid expansion of governmental activity during that period. The scientific management approach to administration strongly influenced budgeting practices throughout the 1940s. Reflecting this management orientation, budgeting systems were used increasingly to assess and improve administrative performance and worker output. During this period performance standards and work measurement techniques were introduced and developed. In 1949, the first Hoover Commission advanced the concept of performance budgeting by recommending that expenditure classifications be based upon functions, programs, and activities. (In comparison, the management-oriented functional-object budget delineates broad categories such as administration, salaries, plant operation, plant maintenance, fixed charges, capital outlay, and debt service.)

The third stage of budget reform began in the early 1960s with the introduction of PPBS. The adoption of PPBS by the Department of Defense (DOD) in 1961 was preceded by a considerable amount of research by the Rand Corporation throughout the 1950s (McKean, 1958; Hitch & McKean, 1960). Basically concerned with analyzing the performance of military weapons systems for the DOD, several economists associated with the Rand Corporation developed the basic concepts and techniques of PPBS. David Novick (1964), a Rand economist, edited a series of publications which became the first definitive work on program budgeting.

In 1965, President Johnson directed the major civilian agencies of the federal government to implement PPB systems similar to the one used in the DOD. Influenced by federal budgeting reforms, various state and local governments also initiated projects to develop and implement program budgeting techniques. In 1968, at a time when some school districts were beginning to experiment seriously with PPB systems, Hartley (1968) explored the application of PPBS concepts to education and Benson (1968) advocated the use of PPBS in education to reduce deficiencies in the allocation of public resources. A short time later, the Rand Corporation published a comprehensive report exploring the potential use of PPBS concepts and techniques in educational planning (Haggart, et al., 1969).

The performance budgeting approach advocated in the 1950s is based upon concepts drawn from the scientific management movement. It concentrates on inputs and uses cost accounting procedures. In contrast, program budgeting

is based upon concepts borrowed from systems analysis and economics. It focuses on outputs and utilizes program accounting techniques. More importantly, while performance budgeting assumes that objectives are fixed, program budgeting assumes that objectives may be variable. In a PPBS, then, systematic analysis of relevant alternatives can lead to a revised statement of objectives. The program budget becomes, in effect, a policy statement.

A fully operational PPBS includes multiyear program and financial plans for projecting future cost implications. To estimate costs and benefits over an extended time period, PPBS requires an end-product classification system that systematically relates expenditures to designated objectives. Accordingly, an appropriate program structure must be devised to facilitate grouping of the activities and their associated costs into appropriate categories based upon their relationship to objectives. Program structures typically are hierarchical classification schemes that group an organization's activities into programs, subprograms, and program elements. A program may be defined as a set of activities that function together to achieve the same objective(s).

Grouping of budgetary data by programs facilitates the analytical process. While there is no single "ideal" program structure, classification schemes should possess certain characteristics. For example, program structures should be multidimensional, i.e., they should provide for the categorization of activities by several criteria. Various cross-cutting sets of program categories may be needed for different analytical purposes. In addition, classification schemes should be flexible. Program categories should be developed and altered as analytical needs change.

A number of educational program formats are possible. In the most common approach, the program cost structure is simply based on grade levels. Programs might include the kindergarten through third grades, fourth through sixth grades, seventh and eighth grades, and the high school years. In a second approach, programs are based on curricular areas and costs are apportioned to specific curricular areas, such as reading, language arts, mathematics, science, and social studies. In a third option, a combination of the first two approaches, program costs are organized by subject matter and by grade levels. The development of this kind of program-accounting scheme, however, requires access to a sophisticated system for information storage and retrieval.

Current school budgeting practices do not reflect widespread acceptance of program budgeting techniques. Most school budgets still employ traditional classification schemes which emphasize the fiscal control or accountability aspect of the budgeting process. The following major expenditure accounts, recommended by the U.S. Office of Education in 1957, are still used extensively by school districts today (Reason & White, 1957):

Expenditure Accounts

Administration
Instruction
Attendance and health services
Pupil transportation services
Plant operation
Plant maintenance
Fixed charges
Food services and student body activities

Community services
Capital outlay
Debt service from current funds
Outgoing transfer accounts

While this accounting format is useful for fiscal control purposes, these broad functional categories do not provide the detailed cost information necessary to improve resource allocation decisions. For example, the largest budget category, instruction, typically includes the following subcategories:

Salaries
  Principals
  Consultants or supervisors
  Teachers
  Other instructional staff
  Secretarial and clerical assistants
  Other salaries for instruction
Textbooks
School libraries and audiovisual
Teaching supplies
Other expenses

Clearly, improvements in school budgeting and accounting procedures are necessary to facilitate systematic analysis of resource allocation decisions. Guthrie (1973) suggested the following format as a more useful approach to budgeting and accounting for the instructional function.

Instruction--Reading

Developmental reading, total
  Elementary school services
    Personal services
    Supplies
    Capital outlay
  Junior high services
    Personal Services
    Supplies
    Capital outlay
  Senior high services
    Personal services
    Supplies
    Capital outlay
Remedial reading, total, etc.

The above format categorizes expenditures by level of school program and by type of instruction offered. By utilizing this type of cost structure, allocation of fiscal resources is shown in considerably greater detail. We emphasize the importance of preparing such a functionally detailed budget at the individual school level, since district-wide figures can obscure the impact of school resources at the school, classroom, and student levels. With this type of cost information, however, educational decision makers and school administrators are in a much better position to assess the cost and effectiveness of specific instructional programs.

As is often true with innovations in education, claims concerning the benefits of PPBS were exaggerated and it has fallen from favor in recent years. Converting a traditional functional-object budget into a multiyear document stressing long-range planning and focusing on operational objectives is a difficult task. PPBS, for instance, rests on the assumption that objectives can be specified. Yet the specification of objectives invariably involves value judgments. No PPBS can resolve the inevitable disagreements which arise concerning the objectives which should be pursued and the priorities which should be assigned. Nevertheless, PPBS forces decision makers to clarify their values by identifying and operationalizing organizational objectives. Despite its shortcomings, then, PPBS has considerable utility as a management tool and clearly sets the stage for cost-effectiveness analyses.

VI

COST-EFFECTIVENESS ANALYSIS

Systems analysis, economic theory, and PPBS all emphasize one basic notion--the examination of alternative means to achieve given ends. Cost-effectiveness analysis implies that the preferred alternative(s) will be selected on the basis of efficiency criteria. Characteristic of most cost-effectiveness definitions is that of Seiler (1969, p. 1) who defined cost-effectiveness analysis as a

> procedure by which the costs of alternative means of achieving a stated effectiveness, or, conversely, the effectiveness of alternative means for a given cost, are compared in a series of numerical indices. The objective of the analysis is to isolate the alternative or combination of alternatives that either gives the greatest expected effectiveness for a given expected cost or a given expected effectiveness for the least expected cost.

Several writers have advocated this basic approach for comparing alternatives in cost-effectiveness analysis. Haggart (1969, pp. 152-159), for example, in addressing educational planning, found it useful to hold either the cost (i.e., budget level), or effectiveness (i.e., student achievement) constant. In other words, meaningful comparisons can be made between the cost of different alternatives for achieving a prescribed effectiveness level or between the effectiveness of different alternatives for a fixed budget level. There is no sound basis for comparisons, however, if the alternatives differ in terms of both cost and effectiveness. Haggart argues that maximizing the cost-effectiveness ratio for the sake of the ratio alone can lead to ridiculous extremes--like zero to infinite cost or zero to infinite effectiveness.

To maximize pupil performance, educational decision makers are concerned with using school resources as effectively as possible. Cost-effectiveness analysis is a tool that can assist educational decision makers in choosing among alternative courses of action as they seek to allocate resources efficiently. In their discussion of educational planning, Carpenter and Haggart (1970, p. 2) indicated that cost-effectiveness analysis may be used (1) to help assess the relative worth of several innovative programs with the same educational outcome (such as improvement in reading achievement), (2) to determine whether a single program is becoming more or less effective as time passes so that steps may be taken to improve it, if necessary, or (3) to help assess the relative worth of the same program for different student populations (such as those with different socioeconomic backgrounds) or in different school settings.

Researchers at the Rand Corporation were among the first to examine the role of analysis in the program budgeting context. Fisher and Quade agreed that most major long-range planning decision problems must ultimately be resolved primarily on the basis of intuition and judgment and that the main role of analysis should be to try to sharpen this intuition and judgment. After emphasizing that there exist no universally accepted procedures or rules for conducting cost-effectiveness analyses, each researcher described some basic characteristics of a sound analysis.

Fisher applied the term "cost-utility" to the analytical process involved in program budgeting. For Fisher, the process of analysis included the systematic examination of relevant alternatives, the design of new alternatives, and the modification of initially specified objectives. Fisher (1971a) itemized the major attributes of cost-utility analysis as follows:

1. The essential characteristic is the systematic examination and comparison of alternative courses of action. The courses of action are those which might be taken to achieve specified objectives in some future time period.

2. Not only does one consider those relevant alternatives that are revealed under initial search but one constantly seeks to design new alternatives.

3. The systematic examination of alternatives, both old and new, frequently suggests some modification in the objectives themselves. This is to be encouraged.

4. Critical appraisal of alternatives rests mainly on the assessment of costs, both direct and indirect and in the future as well as in the present, and the assessment of gains or benefits that accrue to each of the different courses of action.

5. While most of the work is quantitative in nature, it should frequently be supplemented by qualitative analysis.

6. The time period of the analysis is an extended one. This creates problems in the treatment of uncertainty that should be dealt with explicitly.

Similarly, Quade (1971, p. 295) contended that the use of the label "cost-effectiveness analysis" placed undue emphasis on a single aspect of the decision-making process. He argued that other aspects of a problem are more important than the comparison of alternatives--"The specification of sensible objectives, the determination of a satisfactory way to measure performance, the influence of considerations that cannot be quantified, or the design of better alternatives." Quade's principles of sound analysis specified that (1971, pp. 299-300):

1. The right problems must be tackled, i.e., discovering the appropriate objectives, searching out good criteria for choice, and choosing the best set of alternatives to compare.

2. The analysis must be systems oriented, i.e., finding the interdependencies that exist in a system's parts and studying the entire complex system even if it requires intuitive judgment.

3. Uncertainties should be recognized and an attempt should be made to take them into account by evaluating their impact on the answers. Answers change in response to changes in assumptions and estimates.

4. The analysis should attempt to discover new alternatives as well as to improve the obvious ones.

5. The analysis should strive to attain the standards traditional to science even though in problems of public policy the scientific method of controlled repeated experiment cannot be used. These are (a) intersubjectivity: results obtained by processes that can be duplicated by others to attain the same results; (b) explicitness: use of calculations, assumptions, data, and judgments that are subject to checking, criticism, and disagreement; and (c) objectivity: conclusions do not depend on personalities, reputations, or vested interest; where possible these conclusions should be in quantitative and experimental terms.

Those who attempt to apply systems analysis and cost-effectiveness analysis to problems must confront major elements of uncertainty because of the extended time horizon, which usually involves a projection into the future of at least five to ten years. Fisher (1971a, pp. 190-91) advocated the use of sensitivity analysis, contingency analysis, and a fortiori analysis in treating the troublesome feature of uncertainty inherent in most long-range planning problems.

In the first technique, sensitivity analysis, the expected values of the key parameters are varied. If the costs of particular resources are uncertain, an array of high, medium, and low values can be used to examine the various alternatives. In this manner, an effort is made to determine how sensitive the results (the ranking of the alternatives being considered) are to changes in key parameters. In the contingency analysis approach, the effect on the ranking of the alternatives of changes has been called the "what if" approach. In it, a major change in the general environment can be assumed. In the third technique, a fortiori analysis, all questions of uncertainty may be resolved adversely with regard to the intuitively preferred alternative. The preferred alternative is then compared with the other possible alternatives. A strong case for the preferred alternative is assumed if it still compares favorably with the other alternatives despite the built-in adverse conditions.

While the problem of treating uncertainties presents some major difficulties, it is not the only problem which must be confronted. Analysis of the costs and effectiveness of a range of alternatives also involves problems. In the following section we will examine the basic notion of economic costs, various types of costs, and appropriate cost comparisons. Similarly, in the section on the analysis of effectiveness we will consider the problems inherent in measuring program outcomes.

ANALYSIS OF COSTS

A discussion of costs must begin with the notion of "opportunity costs," which can be defined in terms of "what is given up" rather than "what is put in [Bowman, 1966]." The concept of opportunity costs involves the problem of choice and the examination of alternative uses of resources. If resources are consumed in achieving one objective, they cannot be used to accomplish other purposes. The real cost of any alternative, therefore, is the sacrifice incurred because the decision maker chose not to pursue some other alternative. "Costs occur when a choice is made among several desired benefits. In short, costs are benefits--benefits given up by choosing to do one thing rather than another [Haller, 1974]."

In any analysis, this broad notion of costs must be considered along with the more obvious direct expenditure items. Schultz (1963) developed the concept of opportunity cost within an educational context by examining the costs of a college education to illustrate the significance of foregone alternatives. When people withdraw from the labor force to attend school, society foregoes their productive services and the individuals themselves forego earnings. The costs of these lost earnings to both society and individuals must be calculated as part of the total investment in a college education. Schultz suggested that approximately 60 percent of the cost of college consists of foregone earnings.

Similarly, Thomas (1971, p. 32) argued that time spent within school might better be governed by the principle of "foregone learning." He explained that "the implication here is that the cost of a given curriculum or of a given instructional procedure is measured in part by foregone opportunities to devote students' and teachers' time to other curricula and procedures." The time students spend in study halls, for example, cannot be used for classroom instruction in English, mathematics, or other subjects. Likewise, when teachers are assigned to supervise a lunchroom or playground, the school foregoes their presence in classrooms. Administrative decisions involving the scheduling of pupils and teachers are not without cost considerations; the time of pupils and teachers, as well as school space, equipment, and supplies, are all limited.

Several writers have addressed the pitfalls involved in conducting cost analyses. Bickner (1971) thoroughly delineated the problems in performing cost analyses of military programs. Haller (1974) discussed many of the same problems within an educational context. Typically, two basic procedures are followed to determine the costs of program alternatives. First, a listing of the specific resources required for each program is developed and then a monetary value is assigned to the resources identified.

After all necessary resources have been identified, a comprehensive input structure that accurately allocates specific costs to particular programs is developed. As discussed previously, a classification scheme should be designed to facilitate the analytical process and permit meaningful comparisons. The major expenditure categories for personnel, facilities, equipment, and materials should be divided into subcategories to delineate costs in as much detail as necessary. At the same time, the classification scheme should also treat the time of students and school personnel as a valuable resource.

The input structure also should relate expenditures to their purposes in the program. Fisher (1971b), for example, discussed the notion of a program life cycle. New educational programs, as well as changes in existing programs, normally involve a stream of costs over an extended time period. These costs can be segregated into the following three categories (Haller, 1974, p. 420):

1. Research and development costs--resources required to develop the program to the stage where it can be introduced into the system. For example, the time a science coordinator spends in investigating a possible program, money used to hire consultants, and evaluation effort are appropriately classified as research and development (R & D) costs.

2. Investment costs--costs necessary to implement the program. Equipment purchases and the costs of running a workshop to train staff are examples of investment costs.

3. Operating costs--recurring costs required to operate the program over time. Maintenance of equipment, salaries of personnel, and cost of supplies are examples.

An example of these costs over the life cycle of a program is illustrated in Figure 1. Each type of cost typically behaves somewhat differently over time and is incurred at different stages in the implementation process. Research and development and investment costs usually have their greatest impact early as compared with operating costs which occur later but extend over a potentially much longer time period. An examination of R & D, investment, and operating costs helps focus attention on the time horizon of the program and the projection of future costs.

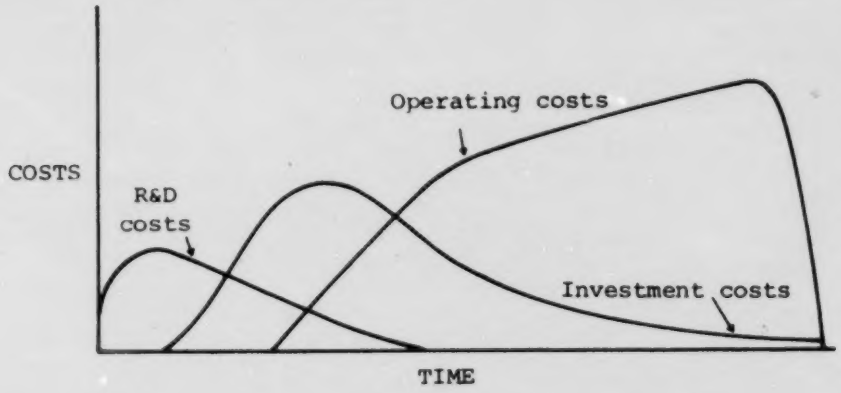

Figure 1. The relationship between costs and the life cycle of a program.

Source: Haller, 1974, p. 421.

Decisions made today are likely to incur costs over a period of several years and may limit possible options in the future. Therefore, cost-effectiveness studies must be concerned with the estimation and analysis of future costs. Costs can never be estimated with absolute accuracy and the further into the future one attempts to project costs, the more uncertain the analysis. While the input structure should accommodate a comparison of alternatives over an extended period, it generally is not advisable to develop a highly detailed set of cost categories when a relatively long time period is involved. The cost of constructing and operating such a cost structure would probably outweigh the benefits ob-

tained, i.e., would not be cost-effective! As mentioned previously, however, techniques such as sensitivity analysis and contingency analysis may be used to sharpen the evaluation of alternatives.

Once a multidimensional input structure has been developed, a good general rule is to allocate time to the analysis of each cost category in a manner roughly proportionate to each category's share of the total budget. Thus, the personnel category, which typically represents 70 to 80 percent of the educational budget, should receive closest scrutiny. Costs for personnel salaries and wages generally can be assigned in a rather straightforward manner. Direct salary payments, however, do not reflect fringe benefits and other costs that employers must pay. Payments for items such as retirement, social security, health insurance, and life insurance frequently comprise 20 to 30 percent of a school district's personnel costs. In addition, the value of volunteer contributions--such as library aides or playground supervisors--should be included in the analysis.

A school district's salary schedule can be used for projecting future costs of educational programs. Teacher salaries are determined largely by two variables, years of teaching experience and level of education. Thus the composition of the staff in terms of experience and training will have considerable impact on the cost of a program. A staff composed primarily of beginning teachers will cost substantially less than a staff composed primarily of experienced, highly trained teachers. Information useful in projecting salary costs can be obtained by examining a district's salary schedule along with the characteristics of the teachers employed. Future costs can then be projected by estimating the movement of staff through the salary schedule over a program's time horizon, as well as projecting the impact of possible changes in the schedule itself.

Costs of facilities or space also represent a major expenditure category. These costs are generally more difficult to estimate than the salary schedule. Thomas (1971, p. 44) identified five components of the cost of classroom space as (1) interest on unpaid debts; (2) foregone interest on equity; (3) depreciation, or annual decrease in value; (4) overhead, or heat, light, and power; and (5) maintenance.

To illustrate these costs, Thomas used as an example a 1,200 square foot biology laboratory. He assumed that another 25 percent of that space (300 square feet) is needed for supporting space (corridors, etc.), that the cost of construction was $16 per square foot (making a total cost of $24,000), and that the present value (after depreciation) is $20,000, of which $15,000 is still owed. The cost of the space is calculated as follows:

1.	Interest on debentures (assume 4 percent of $15,000).	$ 600
2.	Imputed interest on equity (assume 5 percent of $5,000).	250
3.	Depreciation (assume additional expected life of 20 years).	1,000
4.	Maintenance.	400
5.	Overhead (light, power, heat).	400
	TOTAL COST	$2,650

Space requirements are an important ingredient in any cost analysis. Space is a limited resource and decisions regarding its use involve opportunity costs. For example, classrooms used for study halls cannot be used simultaneously for

other purposes. When considering the value of foregone alternatives, the cost for space may constitute a significant portion of total costs. Since new educational programs seldom require construction of new facilities, however, cost of space is often disregarded.

In comparison to the opportunity costs of time or expenditures for salaries and facilities, the cost of equipment and supplies generally constitutes a small part of a total program budget. Educational programs particularly are labor-intensive while equipment and supply costs are generally minor considerations. Frequently rule-of-thumb estimates for equipment and supplies will suffice. For example, the total supply cost can be estimated by dividing total expenditures for supplies by the total number of pupils enrolled and then applying this per pupil cost to the number of pupils served by the program under consideration.

Bickner (1971, p. 35) pointed out that the major responsibility of the cost analyst is to distinguish between relevant and irrelevant costs:

> All costs are relevant to some decision or other, past or future, for otherwise they would not be costs. The responsibility of the cost analyst, however, is not simply to add up any and all costs indiscriminately, but rather . . . to identify and measure that particular collection of costs that are contingent upon a specific decision or choice under consideration. . . . Any cost that will be incurred no matter what choice we make, any cost that must be borne regardless of the decisions at hand, is not a cost of that particular choice or decision.

Costs can be categorized in a number of ways for analytical purposes. Economists, cost accountants, and cost analysts apply a variety of terms to distinguish one type of cost from another, for example, sunk and incremental costs, fixed and variable costs, and recurring and nonrecurring costs. These different categorizations of costs can be helpful in distinguishing between relevant and irrelevant costs.

Since costs are consequences of decisions, one may contend that the relevant costs are those which lie in the future. The cost of constructing a building, for example, lies in the past. These sunk costs are the result of past choices. They are therefore irrelevant to current decisions concerning how to best utilize space in the future. On the other hand, decisions regarding the future use of a building involve incremental costs. The additional costs that will be incurred because of some proposed change represent meaningful alternatives. Only incremental costs are important in this sense; sunk costs should not be included in the analysis since they only serve to confuse the decision maker.

A distinction should also be drawn between fixed and variable costs. Fixed costs, often called overhead costs, typically include administrative salaries, maintenance, depreciation, and the like. They generally remain stable and do not change with expansion or contraction of a specific school program. For example, a decrease or increase in enrollment in a science program does not usually require a change in administrative staffing. Variable costs, however, are closely related to the size and output of a program, e.g., the number of textbooks required varies directly with changes in enrollment.

When estimating the costs of expanding a program, fixed costs which do not affect the decision at hand should be excluded from the analysis.

Another useful distinction can be made between recurring and nonrecurring costs. As the name implies, nonrecurring costs are incurred only once during a specified time period. An example of nonrecurring costs would be expenditures for an inservice program to train teachers to use new curricular products. Recurring costs are incurred repeatedly (usually yearly) and include expenditures for salaries, materials and supplies, and physical plant operation. As in the previous examples, only those costs incurred within the time frame of the decision should be included in the analysis.

The distinctions between sunk and incremental, fixed and variable, and recurring and nonrecurring costs are not absolute. Bickner (1971, pp. 36-37) notes that costs are related to the time, scope, and horizon of the decision under analysis:

> That is to say, the costs of continuing a certain program (and the dividing line between sunk and incremental costs) depend upon the precise time of the decision. The costs of expanding a program (and the dividing line between fixed and variable costs) depend upon the initial and the revised scope of the program. The costs of extending a program (and the dividing line between recurring and nonrecurring costs) depend upon the initial and the revised termination dates, or horizon, of the program.

Once the relevant costs have been identified and estimated, the costs of alternative courses of action can be compared. The most common analytical procedure involves a comparison of alternatives in terms of their total, average, and/or marginal costs. The most appropriate cost comparison depends on the purpose of the evaluation being conducted or the decision under consideration.

A comparison of total costs is usually necessary when a decision involves the adoption of a new program. The decision maker will need data regarding the cost of the present program as well as the incremental costs required to implement any modifications. In deciding to retain, replace, or modify a program, the total cost implications of any choice must be projected over a specified time period. A comparison of total costs can be quite useful in cost-effectiveness studies which deal with alternatives of about equal effectiveness. Assume, for example, that two different reading programs produce the same level of student achievement. The analyst could simply calculate the cost of each alternative and recommend that choice which minimizes total expenditures.

The compilation of average costs, however, might be more appropriate if two reading programs varied considerably. Assume one program relied heavily upon computer-assisted instruction and other technological aids while the other utilized small group instruction and required additional teachers. Average costs, of course, can be estimated for any number of different units--schools, classrooms, teachers, students, and the like. Examples range from yearly per pupil expenditure to cost per student hour of instruction. The cost unit employed will depend upon the particular decision to be made. In general, the unit of cost used should be closely related to the major cost variables involved. For example, the costs of supplies will

vary directly with the number of students served by a program, whereas equipment costs are likely to be a function of the number of classrooms utilized by a program.

A discussion of average costs leads directly to the notion of marginal costs. Marginal cost may be defined as the incremental cost of providing one additional unit of a specific good or service. The marginal cost approach is particularly helpful in analyzing the impact of a decision concerning expansion or reduction of an existing program. Marginal cost comparisons can be used to help determine the important distinction between fixed costs and variable costs discussed earlier. The costs for teachers and space, for example, may shift from fixed to variable and back again, depending upon variations in student enrollment. Thomas (1971, pp. 45-50) explored the economies of scale in a typical high school program by analyzing the cost of adding another biology class. He assumed that a single biology lab can serve a minimum of 120 students (24 students per period for a five period day) and a maximum of 200 students if overloading is permitted. Figure 2 illustrates the behavior of the cost per hour of instruction as enrollment increases.

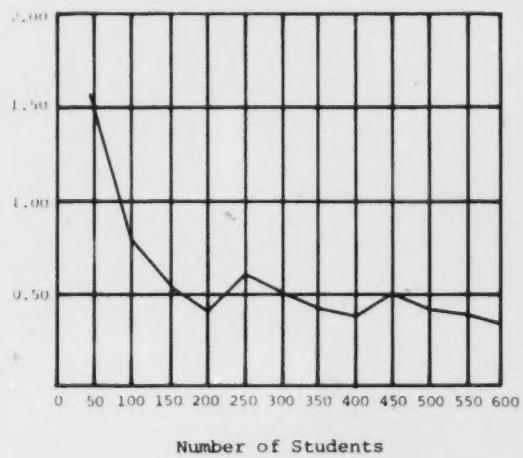

Figure 2. Average cost per student per hour of instruction in biology.

Source: Thomas, 1971, p. 48.

In Figure 2, the average cost per student hour declines rapidly as student enrollment approaches the maximum capacity of the biology class. The average cost line, however, changes direction once classroom capacity is achieved. For purposes of the example, it was assumed that the enrollment of the 201st student requires an additional biology lab and teacher. This hypothetical example illustrates that the expansion of a school program involves relatively small marginal costs per additional student until a capacity point is reached. At that point, the marginal cost increases dramatically. While seemingly a simple task, then, it should be apparent that identification, measurement, and comparison of costs involves numerous potential pitfalls.

ANALYSIS OF EFFECTIVENESS

Costs are used to measure resources that go into a program; the concept of effectiveness is used to assess the output of a program. Program effectiveness can be defined in terms of goal attainment. In short, how much progress has been made toward the accomplishment of designated objectives? Accordingly, an analysis of the effectiveness of an educational program invariably involves an assessment of one or more aspects of student performance.

Like school cost analysis, the measurement of educational outputs involves several difficult problems. At the outset there often is disagreement about the specific outcome desired from an educational system and the relative importance of various outcomes. Some people believe every high school graduate should possess a saleable skill; others are primarily concerned that graduates be qualified to enter the college of their choice; still others are concerned that the school inculcate students with certain values and behavioral patterns.

Educational systems are expected to serve multiple and often conflicting goals and objectives. Educational systems, for example, are urged to provide students with equal educational opportunities and, at the same time, to provide these learning experiences in the most efficient manner possible. The dual objectives of equality and efficiency often conflict with each other and usually involve some type of trade-off. Educational organizations often are confronted with choices that involve greater equality at the expense of efficiency or greater efficiency at the expense of equality.

While the efficiency criterion is typically stressed in cost-effectiveness analysis, the equality aspect cannot be ignored. Assume, for example, that two reading programs result in equal <u>average</u> gains in student achievement. In the less costly program utilizing computer technology, all students demonstrated about the same amount of gain in test scores. In the more costly program stressing individual tutoring, however, students in the upper two-thirds of the group registered modest gains in test scores while students in the bottom third exhibited substantial improvement. Based solely on efficiency measures, the first program is preferable to the second. But if greater emphasis is placed on equality of outcomes, the second program is more desirable than the first even though it is more costly.

Levin (1975, pp. 114-15) pointed out that the distributional consequences of a program should be considered in cost-effectiveness studies. In other words, he is concerned about who receives (or who is supposed to receive) the benefits of a program. Since a particular school program will rarely affect all student populations, e.g., low achievers and high achievers, in an identical manner, an attempt should be made to examine changes in the distribution of gains as well as overall test score gains. The distributional aspects of the gains associated with a school program clearly assume great importance when equalization objectives are the major concern.

Techniques have been developed for treating multiple outcomes in cost-effectiveness studies. Generally, a single criterion of effectiveness cannot adequately detect and estimate the possible effects of a program. In fact, even the measurement of progress toward attainment of a single objective often will require the use of multiple indicators. The assessment of program effectiveness is therefore typically based on a set of indicators or measurements. The selection of specific indicators of effectiveness, of course, depends on the objectives involved and the programs or program activities under analysis.

An output structure similar to the cost input structure discussed earlier is needed. This multidimensional structure should include a hierarchical classification scheme that systematically relates programs and program activities to designated objectives. Likewise, the agreed upon goal(s) must be differentiated into general objectives, performance objectives, and targeted performance objectives. In short, the objectives must be operationalized and stated in measurable terms. Several illustrative structures have been devised that delineate programs, objectives, and output indicators (Mushkin and Cleaveland, 1968).

Since some system goals invariably are regarded as more important than others by the relevant decision makers, the designated program objectives generally are rank ordered or prioritized. Typically, a weighting scheme is used to establish the relative importance of different program objectives. In using such a scheme, various weights or values are assigned to the program objectives or outputs based on their relative importance as perceived by those persons responsible for decisions. This listing of weighted objectives or outcomes can then be aggregated or integrated by the analyst into an overall effectiveness index. Levin (1975) suggested the simultaneous use of alternative weighting schemes in order to clarify the value judgments involved and to reveal the cost-effectiveness implications of the value choices made. An explicit weighting scheme has considerable utility in comparing multiple program outputs.

Similarly, program processes (activities or elements) can be rank ordered with regard to their contribution to the achievement of objectives. By determining the relative contributions of the various program processes to program objectives, comparisons can be made between the different activities within a program or across several programs designed to accomplish the same objectives. Just as objectives must be expressed in measurable terms, performance criteria should be specified for each program component.

In addition to the analytical problems encountered as a result of multiple objectives, educational programs also produce "spillover" or "side" effects. A program designed to improve reading achievement for example, may influence pupil performance in other areas that make use of reading skills, such as history or social studies. Likewise, a teaching strategy designed to stimulate student motivation or enhance student self-concept may also produce gains in cognitive areas. Some programs may generate greater indirect effects than others. Consideration of these indirect effects, both positive and negative, should be included in an evaluation. Thus, program outcomes should be measured along several dimensions.

A major problem in educational program evaluation is the selection of valid and reliable instruments with which to measure pupil performance. For analytical purposes, student behavioral outcomes generally can be divided into two categories--cognitive and noncognitive. While a distinction can be drawn between these two categories, they are not mutually exclusive; they are, in fact, very much interrelated. Affective factors such as student motivation, attitudes, and self-concept may have an important effect on the learning process and academic achievement. However, despite general agreement that affective growth is important, there has been little progress in developing instruments to assess affective behavior. Noncognitive objectives remain extremely difficult to define and operationalize.

Evaluative research in education has been basically concerned with explaining cognitive achievement. It has largely ignored the affective dimension of student growth. Numerous standardized tests have been developed and many of them can be used with some degree of confidence. Nevertheless, the use of standardized tests to measure cognitive achievement can be hazardous. The results of standardized tests are reported in a variety of ways and the different scoring modes must be used in an appropriate manner.

Almost all standardized tests involve the conversion of raw scores into normative scores to indicate a student's relative position in a distribution of scores. Grade-equivalent scores, for example, indicate the grade level at which students are performing. While grade-equivalent scores have some utility, Coleman and Karweit (1970) clearly point out that these scores cannot be used to make inferences about the effect of a school program on the rates of growth of pupils who start at different grade levels.

Specifically, a grade-equivalent score reports a student's position relative to the median of the norm group at a particular grade level. Accordingly, a year of growth is based on the total distribution of scores at that grade level. Since variance in test scores will increase progressively from early to later grade levels, a gain of twelve months will be increasingly more difficult to obtain. In other words, a student who maintains the same percentile over time, that is, the same position relative to other students, will appear to fall farther and farther behind based on grade-equivalent measures.

> A "year of growth" in reading at grade 12 is less, relative to the total distribution of 12th-graders' scores, than a year of growth at grade 6. A "grade-equivalent" score, therefore, means a different thing at every grade level. It does not compare the student to others of the same age or at the same grade level; it compares him to the average or median student at another grade level. It is a relative score masquerading as an absolute score [Coleman & Karweit, 1970, p. 17].

Although percentile scores are better suited for comparison than are grade-equivalent scores, Coleman and Karweit also demonstrated the misleading nature of these scores. The percentile identifies the point in a distribution of scores below which a given percentage of students fall. If a student scores at the 80th percentile, for example, then 80 percent of the total group have scores less than or equal to his. In the normal distribution, depicted by a bell-shaped curve, student scores are clustered closely around the 50th percentile and are much more widely spaced at the extremes, e.g., the 10th or 90th percentile. Thus, "the percentile score stretches out the scale toward the middle, and compresses it at the ends [Coleman & Karweit, 1970, p. 17]." Percentile scores, which permit a comparison of the relative position of students at different points in time, therefore, are useful in determining the direction of change but are not satisfactory for measuring the amount of change that has occurred.

A more accurate estimate of the amount of change can be made by using standardized scores. The distribution of standard scores (Z scores) is based on a mean of zero and a standard deviation of one. The relative position of a score is expressed in standard deviation units. The standardized score permits a comparison of a student's performance on one measurement with his

performance on another measurement. Coleman and Karweit (1970, pp. 17-21) suggested the creation of standardized scores for every grade level. By standardizing the scores, the mean would become the same but a separate standard score would be expressed for each grade level. The amount of change could then be compared more accurately by using the same mean and standard deviation across grade levels.

While standardized tests describe a student's position relative to other students, they do not diagnose the specific skills that have been mastered by the student. For this reason, criterion-referenced tests (as opposed to norm-referenced tests) appear to be better suited for use in cost-effectiveness studies. The distinguishing feature of a criterion-referenced test is its relationship to the specific goals and subject matter of a program of instruction.

> Each item on a criterion-referenced test is designed to measure or indicate the accomplishment of a particular skill. The important factor is which items are passed, not the number. Test scores are for advancing the student, not generally to summarize achievement [Averch, et al., 1972, p. 33].

Like standardized tests, criterion-referenced tests are not without problems. Criterion-referenced tests are developed to evaluate progress toward specific program objectives. As mentioned earlier, widespread agreement on specific objectives is often difficult to achieve. In addition, some objectives are difficult to operationalize in measurable terms. For these reasons, course objectives may be oversimplified in order to construct the necessary test items. Other drawbacks to criterion-referenced tests are that they generally are costly to develop and can seldom be used over a wide range of applications.

VII

COST-EFFECTIVENESS LITERATURE

CONCEPTUAL WORK

In a paper basically concerned with the performance of military systems, Quade (1971) presented a conceptual framework for conducting cost-effectiveness analyses consisting of five basic elements--objective(s), alternative(s), costs, model(s), and a criterion (see Figure 3). Quade viewed the analytical process as involving three overlapping stages. In the first, the formulation stage, the problem is defined, the issues are clarified, and the study is limited. In the second, the search state, alternatives are generated and data are collected. In the final stage, the complex process of comparing or evaluating the various alternatives is undertaken.

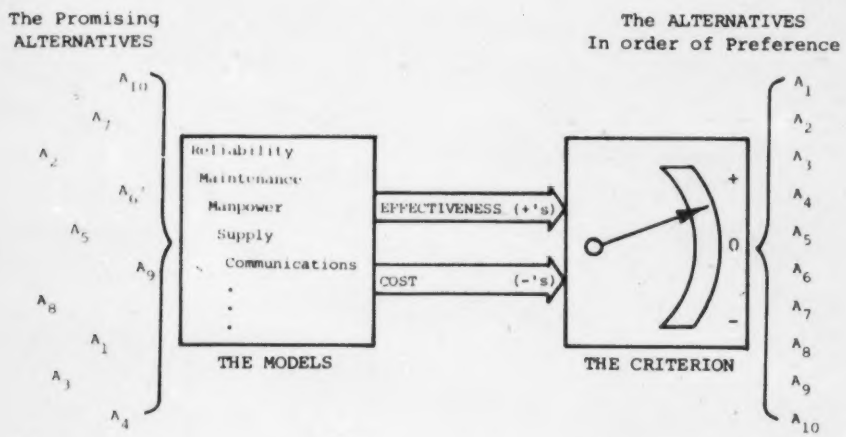

Figure 3. Quade's structure of analysis.

Source: Quade, 1971, p. 296.

Quade emphasized the importance of using a model to compare alternative courses of action in terms of their costs and effectiveness. The model, e.g., computer simulation, linear programming, or mathematical equations, provides "a precise structure and terminology that serve primarily as an effective means of communication, enabling the participants in the study to exercise their judgment and intuition in a concrete context and in proper relation to others [1971, p. 295]." While the controlled replicated experimental approach

can rarely, if ever, be used in policy analysis, Quade argued that every effort must be made to maintain the rigor of scientific methods. In other words, the alternatives must be examined systematically and objectively to permit others to replicate and verify the study.

Working with educational systems, Alkin (1970) constructed a model to (1) compare the cost-effectiveness of alternative instructional programs, (2) evaluate the cost-effectiveness of specific school programs, and (3) determine the cost-effectiveness of using different school input options. The proposed model (see Figure 4) consists of five components: (1) student inputs--the abilities and characteristics of the students entering the school program, (2) financial inputs--the financial resources made available to support the program, (3) manipulatable characteristics--the resource-consuming aspects of the program that can be changed administratively, (4) outcomes--the cognitive and noncognitive changes that occur in students after they have been exposed to the instructional program, and (5) external systems--the social, political, legal, and economic structure of society.

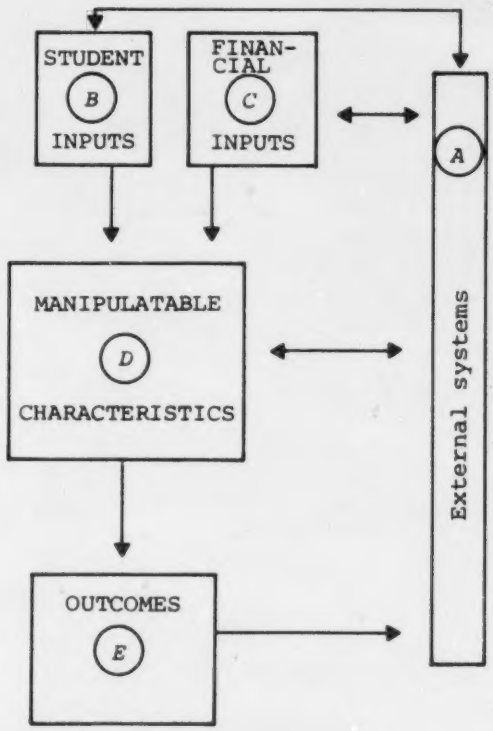

Figure 4. Alkin's cost-effectiveness model.

Source: Alkin, 1970, p. 226.

Depending upon the type of evaluation conducted, Alkin arranges these different components into control, predictor, or criterion variable sets. The cost-effectiveness of alternative instructional programs, for example,

could be compared by using components A and B (external systems and student inputs) as control variable sets, component C (financial inputs) as a predictor variable set, and component E (outcomes) as a criterion variable set. Likewise, individual school programs could be examined by using components A, B, and C as predictor variables with component E as the criterion measure. Various input combinations could be compared by using components A, B, and C as control variables, component D (manipulatable characteristics) as predictor variables, and component E as the criterion.

Abt (1969) developed a cost-effectiveness model to evaluate Elementary and Secondary Education Act (ESEA) Title I programs for the disadvantaged. The model attempts to evaluate the relative school, student, and community effects and associated costs of alternative Title I programs. Abt's input-output model (see Figure 5) includes five submodels: (1) school--the production process of transforming the inputs (different student types and educational resources) into better educated individuals, (2) instructional process--the changes in student behavior resulting from Title I programs, (3) community--the impact on the community of changes in educational outputs due to Title I programs, (4) costs--the direct and indirect costs required to implement Title I programs, and (5) cost-effectiveness--the analysis of the effects and results of Title I programs.

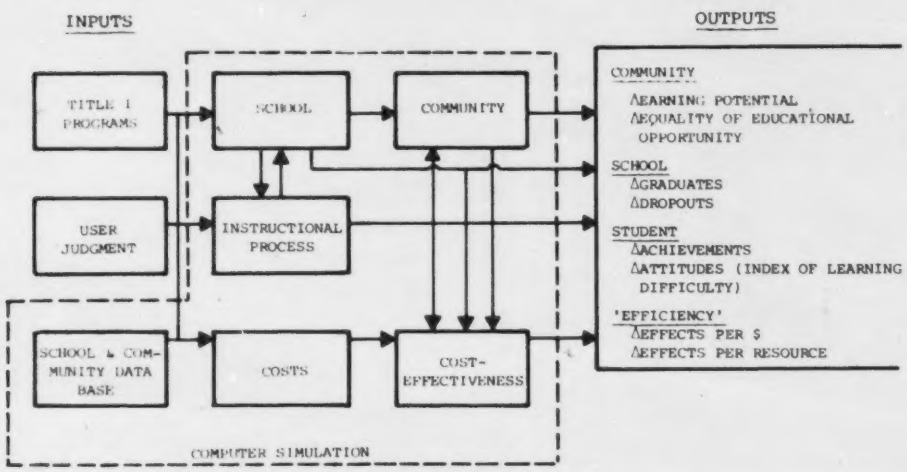

Figure 5. Abt's cost-effectiveness model.

Source: Abt, 1969, p. 67.

This model is designed to program data descriptive of educational systems for computer simulation purposes. Inputs include community characteristics, student demographic data, and Title I program data. Outputs include changes in student achievement and attitude, as well as changes in the number of school

graduates and dropouts. Abt developed each of the five submodels in considerable detail. The school submodel, for example, includes a school flow matrix for monitoring student achievement and a systematic procedure for performing truancy/dropout calculations.

Haggart and Carpenter (1969) developed a model for school district planning based on a planning-programming-budgeting system (PPBS). The model illustrates the various PPBS components and clarifies the important analytical dimension (see Figure 6). The PPBS process begins with a statement of objectives and a categorization of underlying activities and programs. This categorization provides the program structure (P1, P2, to Pn) necessary for generating possible program alternatives (A1, A2, to An). Each alternative must be considered in terms of resource requirements and in relation to several effectiveness measures. The evaluation and selection of a preferred alternative may involve many difficult decisions. Clearly resource requirements will have to be weighed against resource availability and estimates of effectiveness will have to be weighed against designated objectives.

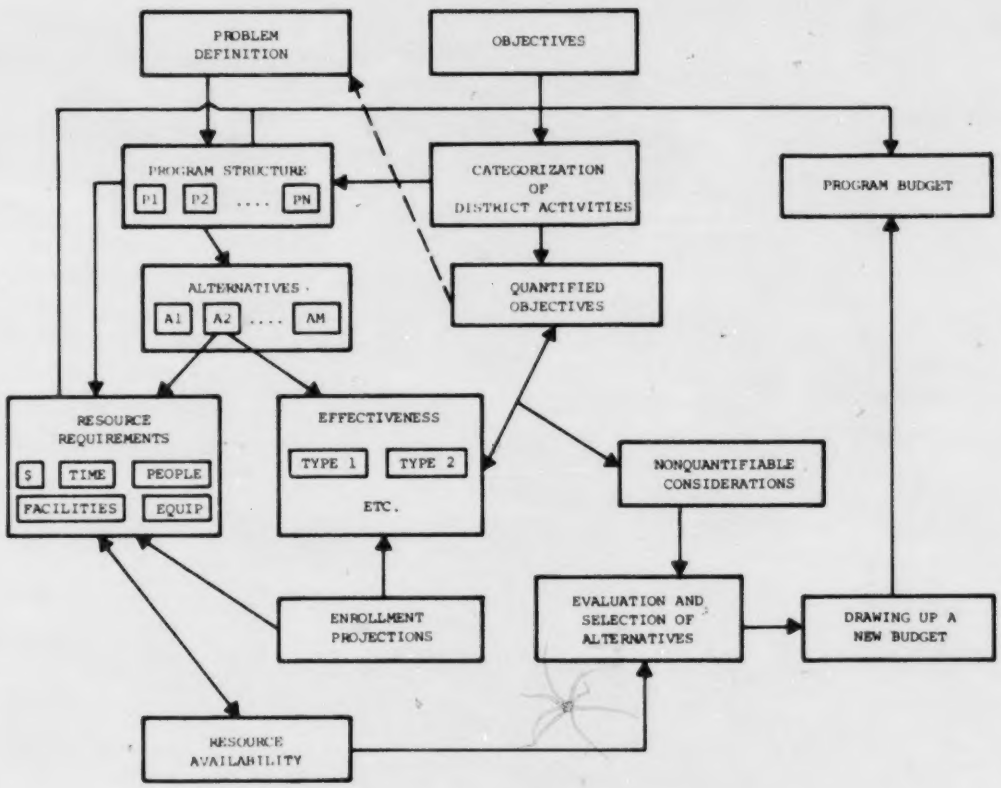

Figure 6. Haggart and Carpenter's analytical model.

Source: Haggart and Carpenter, 1969, p. 2.

Kim and Harris (1976) developed a cost-effectiveness model and data instruments applicable to the management of secondary vocational education programs (see Figure 7). Eight elements for any cost-effectiveness analysis were identified from the literature: (1) the program or alternative programs, (2) program objectives, (3) program cost, (4) program output, (5) a model of the relationships among the elements, (6) effectiveness--the extent to which the objectives are achieved, (7) efficiency--the relationship between the output and the cost, and (8) the ratio of program effectiveness to program cost. The model includes four major components--vocational program classifications, program objectives and specifications, program outputs, and costs. It was designed to generate three kinds of cost-effectiveness measures--effectiveness, efficiency, and cost-effectiveness ratio and/or performance ratio.

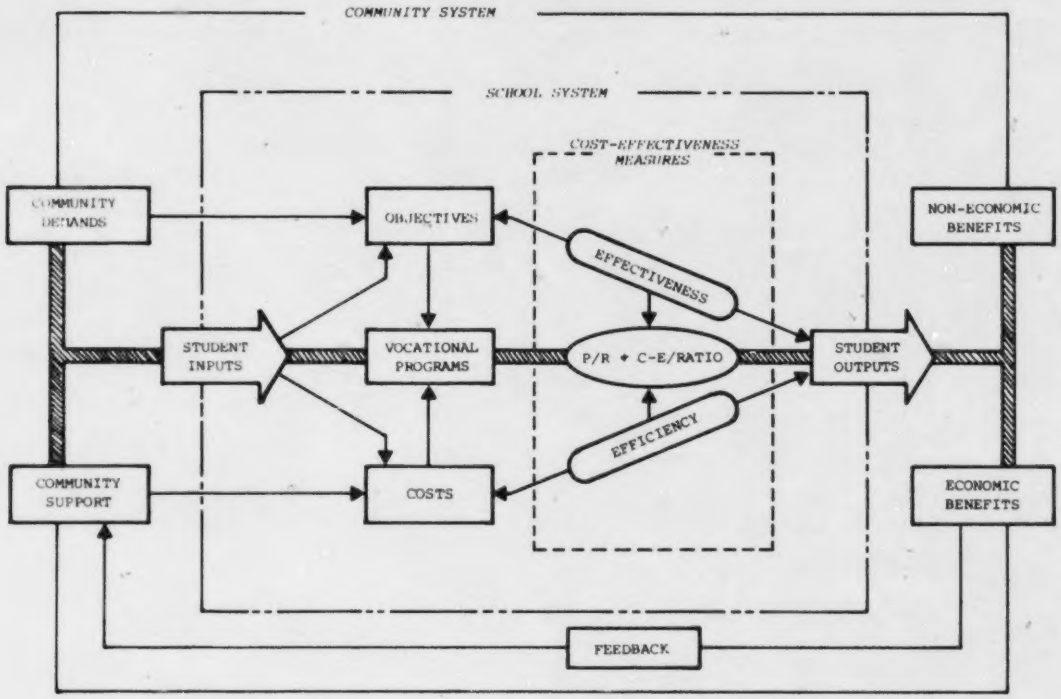

Figure 7. Kim and Harris' cost-effectiveness analysis model for secondary vocational programs.

Source: Kim and Harris, 1976, p. 34.

Seiler (1969) suggested several preliminary considerations which must be dealt with before attempting to measure a system's cost-effectiveness. Possible program alternatives should be assessed initially to determine those which are feasible within the context of a system's overall limitations. In order to

conduct a meaningful analysis, the feasible alternatives must either be homogeneous or equalized with respect to many factors, such as geographical location or scale of measurement, that might otherwise prevent meaningful comparisons. Seiler delineated five basic cost-effectiveness approaches--ratio model, indifference curve model, mathematical programming, theory of games, and probabilistic cost-effectiveness.

The most common technique, the ratio model, measures the "efficiency" of a system in terms of the ratio of its output (effectiveness) to its input (cost). An overall "figure of merit" is obtained by dividing the system effectiveness index by the system cost index. A more useful approach, the indifference curve model, permits an analysis of various combinations of alternative systems. By employing marginal analysis while holding cost and effectiveness constant, an indifference curve model can be used to identify that combination of alternatives which maximizes the figure of merit. The third technique, mathematical programming, includes linear, nonlinear, and integer programming, the calculus of variations, and optimal control theory. Assuming that the functional relationships among the related variables are linear and additive, for example, typical linear programming techniques can be used to determine the optimum allocation of a system's resources or to determine a system's minimum cost requirements.

In the first three models it is assumed that the decision maker can operate in a vacuum, i.e., as if there were no other decision makers in his field. This assumption, however, cannot be made in a competitive system where the decision maker must consider carefully his opponents' possible reactions to the decisions that he might make. An attempt therefore, must be made to identify optimal strategies in confrontation situations. Assuming equal costs, there are different "payoffs" (effectiveness levels), important to different people, over the range of available strategies (alternatives).

In the last approach, probabilistic cost-effectiveness, cost and effectiveness probability distributions are generated for each alternative. This method permits the decision maker to weigh his confidence in the various alternative systems. In concluding his discussion of these models, Seiler pointed out that external factors must be considered carefully when making a choice based on a cost-effectiveness criterion. Exogenous factors--technological advances, the availability of resources, or political considerations--may significantly influence a system and strongly affect any cost-effectiveness decision.

EMPIRICAL WORK

Levin (1970b) applied cost-effectiveness techniques in an analysis of teacher recruitment and retention policies. Since teacher salaries typically account for about 75 percent of a school's operating budget, Levin posed two questions: (1) Which teacher characteristics show a relation to a goal that most of us would accept for the schools, that is, performance on a standardized test of verbal achievement? and (2) What does it cost the schools to obtain teachers with different characteristics?

To answer these questions, Levin used data from the Coleman study to investigate the impact of the teacher's verbal ability and experience on the performance of sixth grade students on a standardized achievement test. Using a production function approach, Levin estimated that the effect of each additional unit of teacher verbal score raised the verbal scores of white students

by an average of .179 points and the verbal scores of black students by an average of .175 points. At the same time, each additional year of teacher experience was associated with an average increase of .060 points for white students and .108 for black students.

Focusing next on the cost dimension, Levin examined the relationship between teacher salaries and the teacher's verbal ability and experience. Based on regression analysis, Levin estimated that teachers were, on the average, receiving about $79 more for each additional year of teaching experience and about $24 more for each additional point of verbal score. Bringing the cost data and achievement results together, Levin concluded that hiring teachers with higher verbal ability would be five to ten times more effective per dollar of expenditure in increasing student achievement scores than would hiring teachers with more experience.

Jamison, Suppes, and Butler (1970) investigated the potential role of Computer Assisted Instruction (CAI) for compensatory education programs in urban schools by reviewing the results of an ESEA Title III funded program in CAI in New York City. The arithmetic achievement scores of students receiving CAI (experimental group) were compared with those of students receiving traditional instruction (control group). Cost-effectiveness values were calculated for both the experimental and control groups by combining cost and performance data under three different sets of assumptions which specified the median case, best case, and worst case. After estimating the costs of one month's achievement gain with CAI for each of the three cases, the researchers concluded that the New York CAI program in elementary arithmetic was a highly cost-effective compensatory education technique.

Curtis (1971) contended that a decision maker must ultimately choose between program processes (or components) rather than total programs. Accordingly, a cost-effectiveness methodology was developed to (1) identify the processes (tasks which consume human and material resources) used to attain common objectives, (2) determine the relative effectiveness of those processes, and (3) compare the cost-effectiveness relationship among the processes. Two reading projects in the Milwaukee (Wisconsin) Public Schools were used to demonstrate this cost-effectiveness approach. Both reading projects enrolled comparable student populations, sought to attain similar objectives, and employed common processes.

A panel of experts was asked to rank order the objectives of the two reading projects in terms of their perceived importance. The various processes were then rank ordered on the basis of their perceived contribution to the attainment of each objective. Initially, the research methodology involved the development of a utility value based on the weighted objectives and processes. In the next research procedure, three output measures--a grade equivalent change in reading achievement, the difference between actual grade equivalent change and expected change, and a change in student attitude toward reading--were considered in determining the relative effectiveness of the processes.

Curtis calculated a utility/cost value for each process by dividing the utility value by the cost per pupil for the process. The relative contribution of each process to the overall effectiveness score was determined by dividing the utility value of each process by the sum of all utility values for all processes. (The total student change score based on all three output measures--the overall effectiveness score--was 2.74). The effectiveness value

for each process was obtained by multiplying the overall effectiveness score of 2.74 by the proportion of contribution made by each process. To obtain a cost-effectiveness ratio for each process, the effectiveness value for the process was divided by its cost per pupil. Table 1 displays the methodology Curtis employed to determine cost-effectiveness of different program components.

TABLE 1

CURTIS' COST-EFFECTIVENESS METHODOLOGY

PROPORTION OF CONTRIBUTION TO EFFECTIVENESS			DISTRIBUTION OF EFFECTIVENESS VALUE TO PROCESS		COST TO EFFECTIVENESS RATIO
Process	Utility	Proportion of Contribution	Process	Value	
K	212	.15	K	.41	$ 6.00/.41
A	205	.15	A	.41	$ 5.63/.41
G	192	.14	G	.33	$ 21.00/.33
B	169	.12	B	.33	$ 5.62/.33
I	141	.10	I	.27	$ 50.00/.27
F	117	.08	F	.22	$ 49.00/.22
J	116	.08	J	.22	$ 5.00/.22
E	112	.08	E	.22	$ 161.00/.22
H	75	.05	H	.14	$ 21.00/.14
C	75	.05	C	.14	$ 38.00/.14

Overall effectiveness score = 2.74

Source: Curtis, 1971, p. 258.

The cost-effectiveness ratios in Table 1 give the decision maker an estimate of the amount of gain that can be associated with a dollar of investment in each process. Processes J (teaching aides organize and catalog reading materials), K (reading research teacher works with individual teachers in the preparation and use of materials), B (teaching aides work in individual classrooms with teachers in the preparation of materials), and A (resource teacher visits each teacher's classroom to provide reading instruction support) have the largest payoffs, yielding approximately .04 to .07 for each dollar invested. Process G (reading resource teacher conducts inservice sessions for the total staff) has the next largest return, yielding a gain of .02. In short, Curtis' methodology produced a prioritized listing of the array of possible processes based on the (1) importance of the objectives, (2) contribution of the various processes to the attainment of the objectives, (3) utility value of the processes, (4) costs of the processes, and (5) effectiveness of the processes.

Kiesling (1972) estimated the relationship of selected educational inputs and the reading performance of disadvantaged children in ESEA Title I projects in California. Kiesling's data were based on a 6 percent sample of Title I projects in California. The projects sampled included 10 percent of the state's

Title I students enrolled in the second, third, fourth, and fifth grades. Kiesling found that the following variables best explained the pooled reading achievement for all students: (1) beginning score, (2) program length, (3) percentage of minority group pupils, (4) minutes of instruction by reading specialists, (5) minutes of instruction by paraprofessionals helping regular classroom teachers, (6) percentage of instruction in a separate facility, and (7) hours of planning per week. In a separate analysis of students in the third grade, however, only beginning score, program length, and specialist instruction were related to reading gains at high probability levels. The school input--specialist instruction--was most consistently related to reading gains, with the strength of the relationship particularly strong in the analysis of the third grade. Translating these findings into cost terms, Kiesling estimated that a $100 expenditure per pupil for reading specialists would provide an additional one-tenth of gain per month of instruction. An additional expenditure of $300 per pupil would buy a "normal" learning rate of 0.7 months gain for participating Title I children.

In another study involving reading curricula, Webster (1972) examined the cost-effectiveness relationship between instructional costs and student achievement gains in several reading programs in Grand Rapids, Michigan. The reading programs studied included three programs in which performance contracts were used: (1) Alpha II, (2) Westinghouse Learning Corporation (WLC), and (3) Combined Motivation and Educational Systems (CMES), plus three additional programs: (4) Project Read, (5) a traditional remedial reading (TRR) program, and (6) a regular (control) program. Webster's data were based on a sample of Title I students enrolled in these programs in second, third, seventh, eighth, and ninth grades. Because of differences in the time allotted for reading activities and unequal class sizes, instructional costs were reduced to a common denominator of student minutes of exposure (SME) for several cost categories. Webster calculated an annual cost per pupil for each program. She then divided this cost by the average one-tenth (.1) grade gain to establish a relationship between program costs and gains.

Analysis of variance was used to examine the gains in student reading achievement. Separate analyses were conducted for the second and third grades, for the seventh grade, and for the eighth and ninth grades. The mean achievement gains by programs and grade levels and the cost per one-tenth (.1) achievement gain for each analysis are presented in Table 2. For the second and third grades, WLC, Project Read, and the control program were most cost-effective, producing the largest gains for the least cost. The WLC program was the least expensive per one-tenth grade gain; the TRR program was associated with the highest overall mean gain but clearly was the most costly program. For the seventh grade, CMES and Alpha II were most cost-effective while TRR had the highest cost per-tenth of achievement gain. For the eighth and ninth grades the two performance contract programs were considerably more cost-effective than the control group. Webster concluded that educators should give consideration to whether or not traditional reading programs should be continued in their present form.

Jamison, Suppes, and Wells (1974) surveyed the research concerning the effectiveness of the following instructional media: traditional classroom instruction (TI), instructional radio (IR), instructional television (ITV), programmed instruction (PI), and computer-assisted instruction (CAI). Student achievement scores were used most frequently to assess the effective-

TABLE 2

WEBSTER'S COST-EFFECTIVENESS ANALYSIS
OF SIX READING PROGRAMS

Reading Treatment Program and Mean Achievement Gain	Grades 2	3	7	8	9
Alpha II	.4	.5	.5	1.0	.8
Westinghouse	.6	.7			
Project Read	.7	.7			
Traditional Remedial Reading	.8	.8	.2		
Combined Motivation and Education			.7	1.1	.6
Control (Regular School)	.7	.4	.4	.3	.4

Cost Per One-Tenth (.1) Student
Achievement Gain in Reading

Elementary Grades 2 and 3	
Alpha II	$ 22.51
Westinghouse Learning	11.82
Project Read	16.34
Traditional Remedial Reading	49.60
Control (Regular Program)	14.28
Middle School Grade 7	
Alpha II	19.89
Combined Motivation and Education	16.23
Traditional Remedial Reading	274.75
Control	23.82
Middle School Grades 8 and 9	
Alpha II	10.47
Combined Motivation and Education	13.18
Control	25.24

ness of these alternative media. After reviewing the studies investigating TI, the authors concluded that few variables appear to be consistently associated with student performance. Two exceptions, however, were noted. First, in most studies, the teacher's verbal ability was positively correlated with student learning. Second, while the research surveyed indicated that the teacher-student ratio has little influence on student achievement, small classes seemed to improve the performance of young children.

Based on a limited number of studies, the authors also concluded that IR, supplemented with appropriate printed materials, is about as effective as TI. At the same time, they found strong evidence to indicate that ITV, used in a

manner that simulates TI, is as effective as TI. Likewise, most research findings suggested that there were no significant differences between either PI or CAI and traditional classroom instruction. Some of the studies, however, reported a saving in student time, which has important implications for overall effectiveness. There is also considerable evidence to suggest that the use of small amounts of CAI in conjunction with regular classroom instruction leads to increased achievement, particularly for slower students.

Jamison and his colleagues cited the high costs of schooling as today's number one problem in education. The prices of school inputs, especially teacher salaries, have been increasing sharply without a corresponding increase in school productivity. The authors believe the productivity of educational systems can be improved by augmenting human effort with technology. In the studies they surveyed, however, alternative technologies were employed primarily to improve instructional quality or to provide enrichment activities. The authors argue that the time has come to explore "much more systematically the potential of technology to reduce system costs through productivity improvement [1974, p. 58]."

Blaschke and Sweeney (1974) reported preliminary results of a study of the cost-effectiveness of compensatory reading programs in Michigan. Their study focused on 25 high-achieving districts and 23 low-achieving districts classified on the basis of 1972-73 Title I evaluation reports of approximately 500 local education agencies. Individual schools were classified as high- or low-achieving on the basis of the school's average grade equivalent unit gain score divided by the number of months between the pre- and post-tests. The effectiveness model employed in the study was based upon groupings of variables which the researchers hypothesized would act together in their impact on the effectiveness of compensatory education programs. The COST-ED model developed by Education Turnkey Systems was used in the analysis of cost, with each program viewed as consisting of one activity in which the student was directly involved (classroom reading activities) and four supportive activities in which the student was not directly involved (planning, training, decision making, and administration). The results of the study indicated that "some schools in Michigan do make a difference and that the characteristics of these schools are in many instances very significant . . . and that the factors which appear to describe, if not make, the difference between effective and non-effective comp-ed programs are for the most part 'controllable' by local district staff, and usually those at the building level. . . . [1974, p. 61]." Among the significant factors identified were the (1) role of the school principal, including how the principal allocated time and delegated decision making to teachers, (2) role of teachers, including amount of decision making delegated to the teacher and amount of time allocated to instructional management activities by the teacher, (3) nature and extent of coordination among the teaching staff, especially between regular teachers and compensatory education teachers, and (4) amount of planning time allocated by the compensatory education director and teachers. The researchers noted that, with regard to resource utilization, "the factors or variables which characterize the differences cost few additional marginal dollars; rather they reflect different time usage patterns of building staff [1974, pp. 62-63]."

The Michigan cost-effectiveness study is being continued by the Michigan Department of Education. It utilizes data for individual pupils and classrooms in an attempt to identify and test the replicability of practices and

processes related significantly to the success of reading programs (Michigan Department of Education, 1976). The preliminary results, based upon application of path analysis to a substantial amount of data, indicate that (1) higher per pupil program costs are associated with higher reading achievement and (2) teacher morale, degree of accountability, and involvement of paraprofessionals are the only variables shown to have direct impact on reading achievement.

The Pennsylvania Department of Education is engaged in a multi-year study of the quality and cost-effectiveness of special education programs in that state and has reported the results obtained from analyses of the first year's data (Pennsylvania Department of Education, 1976). The study involves a random sample of special education classes selected to represent five categories of exceptionality--educable mentally retarded, trainable mentally retarded, socially and emotionally disturbed, brain injured, and physically handicapped. The sample was stratified by (1) number of pupils per exceptionality, (2) elementary or secondary program, (3) range of cost in the programs, and (4) demographic conditions (inner-city, other metropolitan area, suburban, and rural). In addition to data on five cost categories (general administration, special education administration, direct instructional costs, instructional support, and instructional materials and equipment) an indicator of quality instrument was developed based on criteria of effectiveness deemed important by teachers, supervisors, parents, members of advocacy groups, teacher trainers, and special educators.

Analysis of the first year's data revealed that the expenditures for special education did not correlate consistently with quality of instructional programs as measured by the indicator of quality instrument. It also was found that, while expenditure for special education did not correlate consistently with achievement gains, a number of significant relationships did exist. It was found, for example, that "cost contributed significantly to achievement gains in reading and spelling for the elementary educable mentally retarded; in reading for the secondary educable mentally retarded; in reading for the elementary trainable mentally retarded; and in spelling for the elementary socially and emotionally disturbed, physically handicapped and brain injured [Pennsylvania Department of Education, 1976, iv]."

Wolfe (1976) utilized data obtained from the individual records of 627 students enrolled in the Philadelphia Public School System over a three-year period (1967/68-1970/71), and cost information based on the school year 1975/76, to analyze the cost-effectiveness of various ways of reducing school expenditures. Utilizing the production function relationship between school inputs and outputs based on the pupil data and the 1975/76 cost information for the school inputs, Wolfe examined how resources might be reallocated more efficiently if the current budget level were maintained and how resources might be allocated if an across-the-board budget reduction of $30 per pupil were required. Based on the results of her analysis, Wolfe observed that:

> (1) The systematic evaluation of inputs in relation to outputs, combined with cost figures, can increase the effectiveness of educational dollars. . . . (2) The cost per pupil is not directly tied to pupil achievement growth. Current resources can be used more effectively by reallocation. Different expenditure patterns yield very different results. (3) A systematic budget cut yields more satisfactory results than an across-the-board cut. (4) Even in times of budget cuts it may be best to increase expenditures on certain resources (i.e., smaller

classes for low achievers, more experienced teachers for high achievers) and compensate with larger cuts elsewhere to maximize the output of the school system [1976, pp. 18-19].

VIII

A CONCEPTUAL FRAMEWORK FOR ECONOMIC ANALYSIS OF SCHOOLING

Educational organizations and the learning process are extremely complex. At present, educational decision makers have little more than intuition to guide them in determining how to most efficiently use the resources available to schools. There is little reason to expect greater productivity in educational systems until more information concerning the impact of various types of resources on school learning is available to guide educational decision makers.

A systems model of the educational production process (see Figure 8) can provide a heuristic framework for analyzing and thinking about the problems inherent in maximizing the productivity of educational resources. The conceptual framework discussed in this section views the educational production process as a system subject to economic analysis. We take the position that school resource allocation is primarily an economic problem and that the tools of economics and systems analysis should be applied to questions concerning the efficient utilization of school resources. The model we have otulined consists of four major components: (1) inputs to the educational system, including policies which constrain and/or control the system's operation, (2) the formal educational system (school) and the processes associated with that system, (3) outputs of the educational system, and (4) feedback. The conceptual framework, shown in Figure 8, is equally useful for viewing a classroom, school, school district, or even a state as an educational production system. The framework follows the resources which are provided to the formal educational system from its external environment (the school community, school district, state, or nation), through the educational process which occurs within the school, to the educational outcomes. The feedback component ties system outputs to both the educational process and the system inputs. Changes can be made to modify either the process or inputs in order to more efficiently accomplish the objectives.

SYSTEM ENVIRONMENT AND CONTROL

Inputs to the educational system from its external environment can significantly influence the outcomes of schooling. Figure 9 shows in greater detail this first major component of the conceptual framework. Research cited earlier in this paper clearly indicates that a community's socio-economic characteristics, values, attitudes, and expectations bear a significant relationship to the outcomes of schooling. While most people agree that the primary function of schools is "to educate," their views as to what constitutes education vary widely. Various subpublics often hold different expectations for the schools.

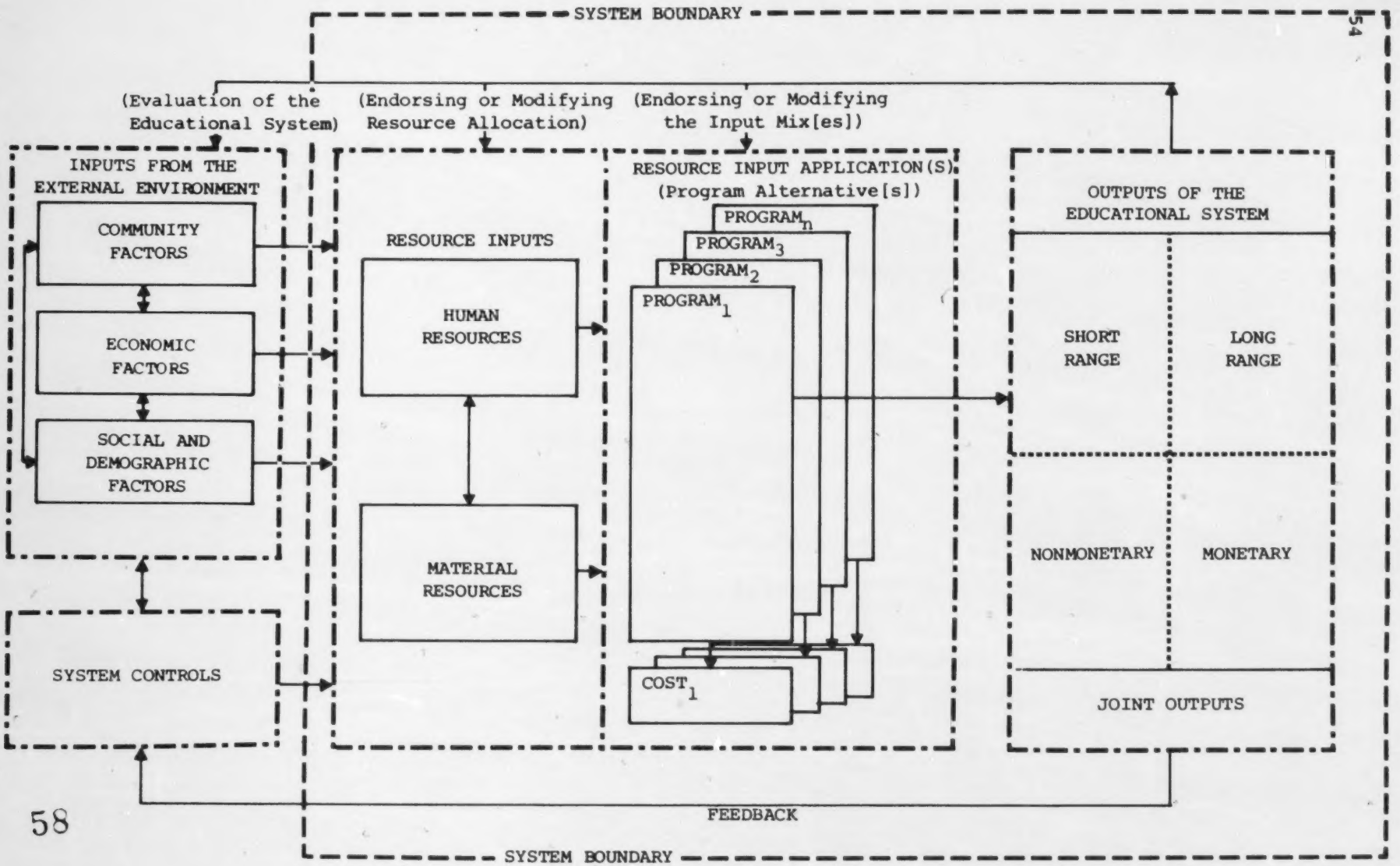

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Figure 8. A conceptual framework of the educational production process under school conditions.

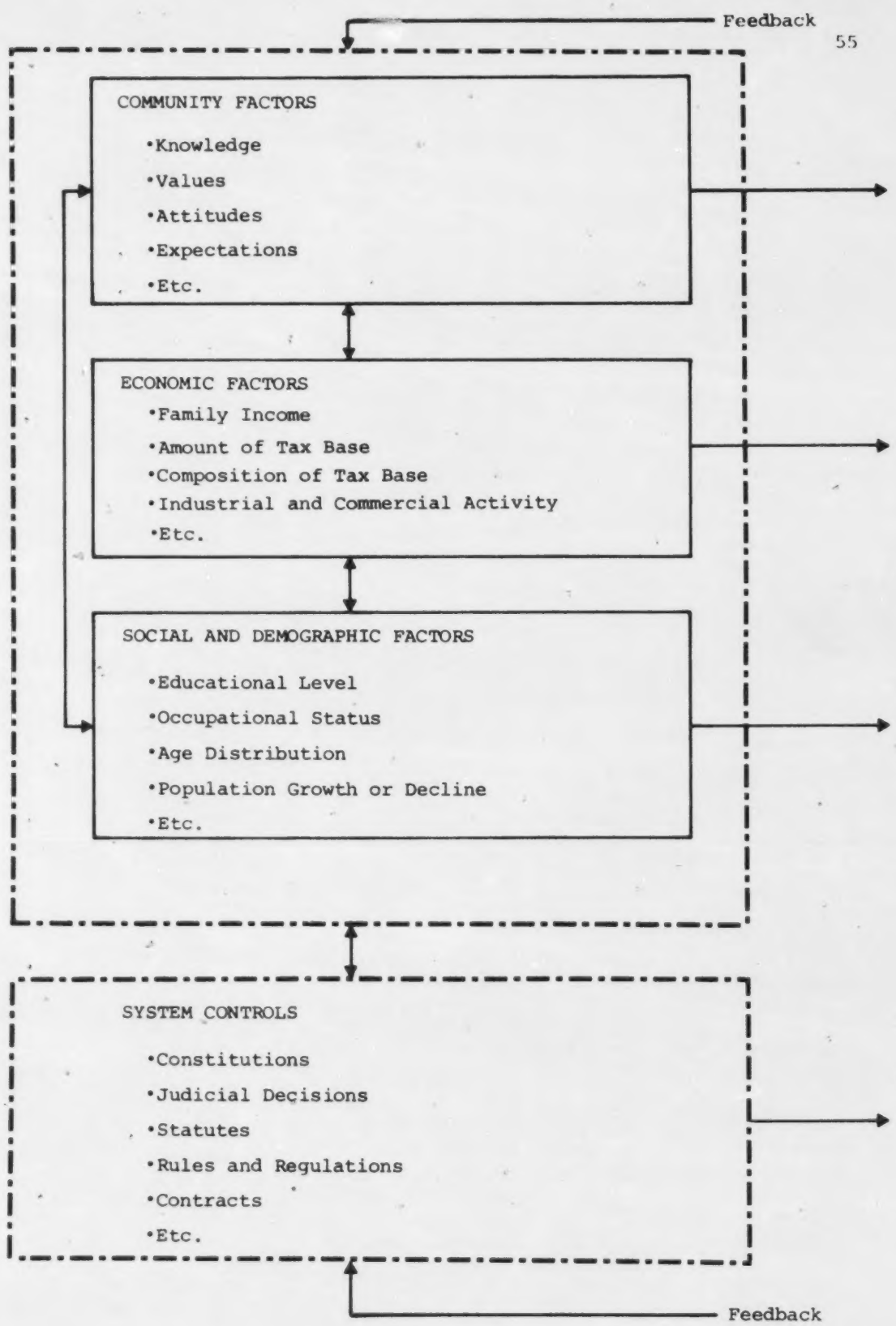

Figure 9. Inputs from the school's external environment.

Another significant input from the external environment is knowledge about the educational process. Professional educators are expected to possess knowledge about human learning and to use this knowledge in selecting appropriate learning activities for students and in making efficient and effective use of the resources made available to the school.

A community's economic base has an important bearing upon its ability to finance education. The level of funding available to the school is strongly influenced by the economic resources (fiscal capacity) of the community and its willingness (tax effort) to support education. Factors such as household income levels, manufacturing activity, and retail sales are important determinants of the community's economic base. Although the level of fiscal resources available to a school is primarily dependent upon the community, state policies concerning educational finance and federal aid programs also are important factors.

The social and demographic characteristics of a community constitute a third set of variables that influence the educational production process. Variables such as the educational level, age, and occupation of adults interact with economic and community factors to shape attitudes and expectations. Population growth or decline and the age structure of the population also affect the resource input of the school. It must be borne in mind that a school does not exist in a vacuum; it exists in an identifiable milieu. The educational processes of the school inevitably must reflect the nature of the community served, the needs of the pupils in attendance, and the expectations held for the school by parents and the public.

System Controls

Public schools must operate within a well defined policy framework. Aims, priorities, and controls are established for schools by elected representatives at local, state, and federal government levels. An extensive system of constitutional requirements, judicial mandates, statutory directives, and administrative rules either influence or control the educational production process.

Schools depend primarily on local property taxes and state and federal aid programs for their operating revenues. In addition to the controls built into its general school aid formula, a state may exercise control over educational policy by imposing spending limitations, establishing minimum educational standards, prescribing curricula, stipulating certification requirements for professional personnel, and the like.

At the local level, a community supplements the controls established by the state by formulating its own set of rules and regulations through a board of education. This board determines (either explicitly or implicitly) the relative importance of various goals, establishes priorities, and identifies objectives. Contracts between a board of education and a teacher organization can impose constraints upon class size, working hours, length of the school year, provisions for inservice improvement, compensation, and other variables directly related to the educational production process.

The aims established for a school district must be translated into educational objectives and defined in terms of an operating educational program. The relative importance assigned to the various objectives will help establish priorities for use of available resources.

THE EDUCATIONAL SYSTEM

The second major component of the conceptual framework is the educational system itself. This may be further subdivided into two elements--school resource inputs and school resource applications. A school district or school has two general categories of inputs with which to work--human resources and material resources. Because the set of aims and priorities reflected in the system controls affects how these resources may be used, school personnel at all levels, from the classroom to the central office, have certain constraints within which they must operate as they seek to achieve specific learning objectives.

School Resource Inputs

Resource inputs to the school may be grouped into two major categories, as shown in Figure 10--human resources (i.e., students, teachers, and staff), and material resources (the physical plant, classroom equipment, curricular materials, supplies, and the like). While school administrators cannot control important home or community background factors or student characteristics, they can exercise control over some school resource inputs and the way they are deployed to help overcome factors that can negatively affect student learning.

Students are the most significant input to the school from its external environment. Research has shown that home and community background factors will strongly influence their aspirations, motivations, skills, and knowledge. Unlike a manufacturing plant which can reject raw material that does not meet quality standards, public schools must work with the pupils who attend them. They cannot arbitrarily reject students who fail to meet some preestablished admission requirement. Because of the differences which exist among students, teachers and administrators must be thoroughly familiar with the community served by the school and must tailor the educational process to meet the needs of individual students. For example, disadvantaged students are likely to need different educational programs and experiences than advantaged students if they are to achieve their full potential.

The personnel employed by the school--teachers, administrators, guidance counselors, psychologists, social workers, librarians, teacher aides, and other personnel directly involved in the learning process--constitute an important input. Similarly, personnel not directly involved in teaching, such as maintenance workers, bus drivers, and food service workers, are important. Research cited previously has demonstrated that teacher characteristics are significantly related to some school outputs and that certain attributes of teachers bear significantly upon some learners and not upon others. Thus, a school administrator must carefully consider the characteristics of current staff members when assessing the qualifications of prospective staff members in order to identify the candidate who will best meet the needs of the particular students to be served. In addition, the school administrator must consider competing priorities, for example, balancing the need for additional classroom teachers against the need for specialists in counseling or health service areas.

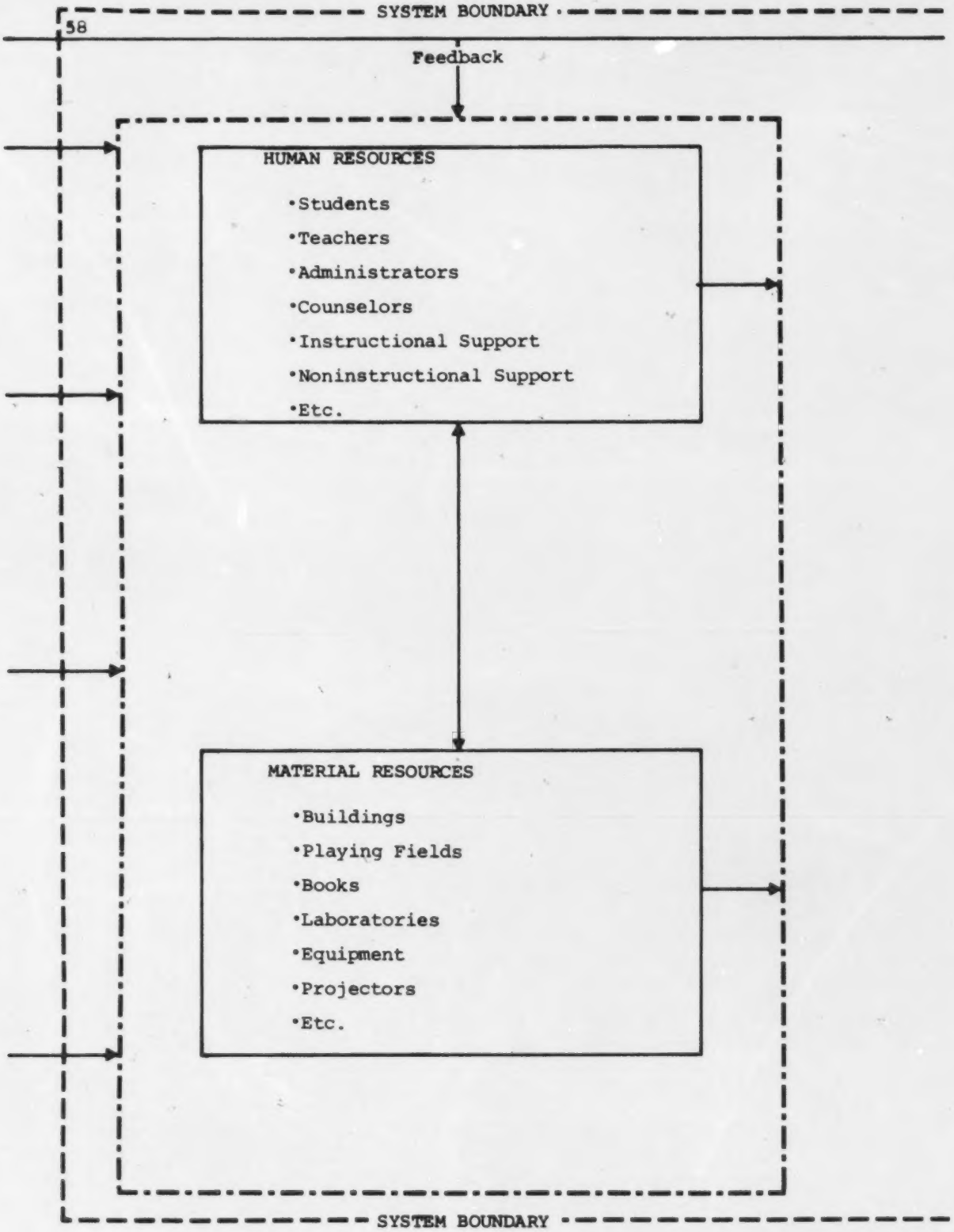

Figure 10. Resource inputs to the school.

The largest material resource, of course, is the school physical plant--the buildings and grounds. In addition to the school plant, computer terminals, audiovisual equipment, desks, books, and an extensive array of other learning aids and equipment are utilized by students and teachers in the course of the educational production process. Previous research has not consistently revealed significant relationships between student achievement and variables such as the age of the school building, the percentage of makeshift classrooms, or number of library volumes, although these variables have occasionally been identified as significant. Because education is a highly labor intensive activity, significant cost savings eventually may be achieved through applications of innovative technology. A computer-managed instructional program, for example, might permit a reduction in cost and, at the same time, increase teacher productivity by performing tedious record-keeping functions. Paraprofessionals or teacher aides might be able to perform non-teaching duties which would otherwise be performed by a teacher.

The Resource Input Mix (Program Alternatives)

A major task of the school administrator and professional staff is identifying the most appropriate manner in which human and material resources may be combined to achieve the goals and objectives of the school effectively and efficiently within the constraints imposed by the system's control policy. In other words, school administrators and teachers must transform the school resources at their disposal into educational programs. Figure 11 illustrates some of the variables they must consider.

School administrators and teachers must rely upon their knowledge and training in organizing the most appropriate instructional programs and in selecting relevant learning activities and experiences for students. Since knowledge about human learning is accumulating rapidly, teachers and administrators must constantly keep abreast of new information gained through research and incorporate it into operational instructional programs. In determining the most effective resource mix, the instructional content--reading, mathematics, language arts, science, etc.--as well as the instructional process variables of the educational program must be taken into account. In attempting to achieve performance objectives established for specific curriculum programs, a school staff must make several important decisions concerning resource use. What type of student grouping patterns will best facilitate the learning process--independent study, one-to-one, small groups of three-five students, class size groups of 25-30 students, or larger groups? How can student time best be utilized? How can the necessary supportive services best accommodate the programs? What type of curriculum materials should be used?

Of particular importance in the instructional process is the utilization of time. In Carroll's model of school learning (1963), time is a central variable. The model's thesis is that students differ in the amount of time they need to master a given unit of learning to a set criterion. As Bloom has noted, "All learning, whether done in school or elsewhere, requires time. . . . Time for school learning is even more limited by the resources available for it, by the ways in which these resources are made available to particular segments of the population, and by the ways in which schools

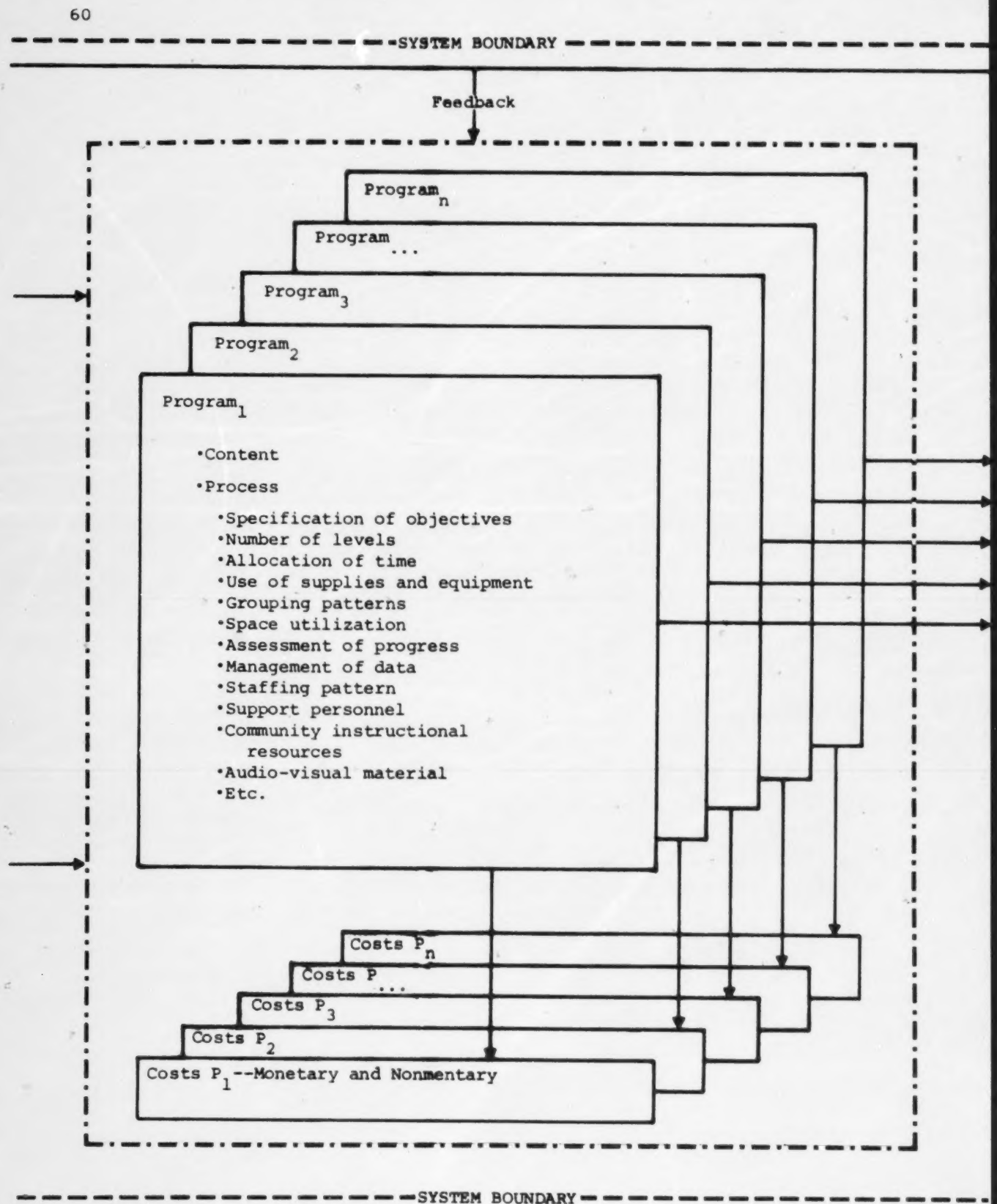

Figure 11. Resource input applications in school programs.

and individuals use the time available to them [Bloom, 1974, p. 682]." Wiley and Harnischfeger (1974) pointed out that several aspects of time as a variable are subject to policy manipulation, for example, length of the school year and school day. They also pointed out that, while the length of the school year and school day establish the maximum time available for exposure to school instruction, "within the limitations imposed by this maximal amount of time, the actual exposure of a pupil to instruction is determined by his attendance, the instructional programs, and the allocation decisions which occur within the classroom [1974, p. 11]." Thus, time must be considered a significant factor in the resource input mix.

Unlike socioeconomic factors or the innate abilities of students, professional educators can manipulate educational program and process variables in an effort to enhance student learning. Unfortunately, they do not always exercise this discretion wisely as evidenced, for example, by the common practice of holding to a uniform class size. It would appear from the research that class size should depend more on interrelationships among teacher characteristics, curricular areas, and student abilities, than upon administrative convenience.

Educational decision makers need to generate and examine various resource mixes. Cost-effectiveness comparisons become possible when "value added" measures (e.g., gain scores) and the costs associated with them are obtained for each program alternative. The relative cost of all inputs, as well as their impact on the learning of individual students, must be analyzed carefully in order to determine how to allocate resources more efficiently. For example, some students may learn more in smaller classes but a sizeable across-the-board reduction in class size may not be feasible because of the cost involved. Thus, decision makers may wish to seek out other policy changes which may produce similar results at considerably lower costs and hence greater efficiency.

OUTPUTS OF THE EDUCATIONAL SYSTEM

The third major component of the conceptual framework, illustrated in Figure 12, encompasses the outputs of the educational system. As was the case in the other components, value preferences come into play. There exists considerable disagreement about the objectives of schooling and the priorities which should be assigned to the various outputs of schooling. Even within a school district or the attendance area served by a school, substantial disagreement may exist among various subpublics on questions concerning the goals and priorities of schooling.

The outputs of an educational system may be classified in various ways. For example, outputs can be categorized as short-range and long-range, as cognitive and affective, or as monetary and nonmonetary. The fact that these categories are not mutually exclusive provides potential for a very complex matrix of outputs. However categorized, outputs must be compared with the goals and objectives established for the educational system, as well as with program cost. The system's effectiveness and efficiency are evaluated by comparing outcomes and costs with established goals and objectives. This performance evaluation identifies discrepancies between objectives and results, and provides the system with information which may be used to validate or modify either the inputs, the process, or both.

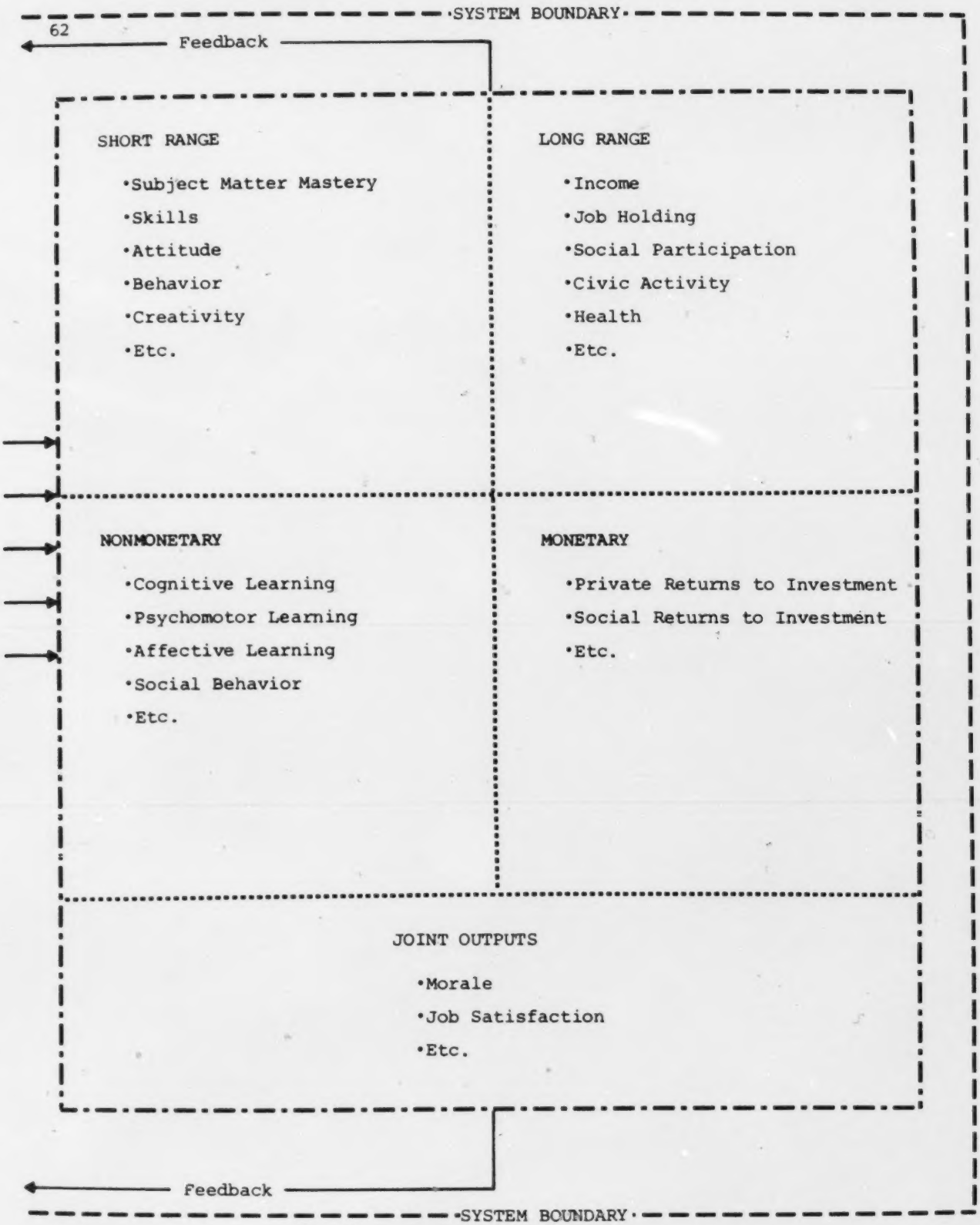

Figure 12. Outputs of schooling.

For purposes of illustration, we have identified five categories which might be used to classify the outputs of schooling--short- and long-range outputs, monetary and nonmonetary outputs, and joint outputs. Note that these are not mutually exclusive categories. Subject matter mastery may be classified as either a short-range or nonmonetary output, or both. Similarly, income may be classified as a long-range output or as a monetary output. The purpose of the analysis is the determining factor in choosing the measures of output that should be employed.

A number of input-output studies have focused on the monetary outputs of the educational system utilizing rate of return analysis to evaluate the private and/or social rates of return to investments in education at various levels of schooling, e.g., completion of eight grades, completion of twelve grades, completion of four years of college, etc. The analyses have focused large groups of individuals rather than on individual students as investors. Although researchers recognize that both the private and the public sectors of the economy benefit from investment in education, it has proven difficult to forecast the returns to individual students from such an investment.

The short-range outcomes of the educational process may be demonstrated in many ways. Perhaps the most familiar are standardized measures of cognitive, affective, and/or psychomotor performance. However, students may establish that they have accomplished educational objectives by demonstrating their possession of basic knowledge; displaying intellectual or motor skills; displaying powers of reasoning and criticism; demonstrating through behavior and performance the possession of certain values, attitudes, and motivation; expressing through their actions a sense of cultural appreciation or a sense of social responsibility; or demonstrating their ability to learn independently. Some outcomes of schooling can be ascertained through standardized achievement tests or tests of basic knowledge; other outcomes are best assessed by observing a student's performance of certain tasks requiring intellectual and/or motor skills. Still others are best assessed through anecdotal records and observations of students both within and outside the school. It is imperative that there be a direct connection between the objectives established for the school and the performance measures used to assess educational outputs. If schools are to be held accountable for the performance of certain functions, the measures by which they are judged must accurately reflect the established objectives. This implies that measures in addition to performance on standardized tests must be utilized if the outputs of the educational process are to be evaluated adequately and fairly.

Other outcomes which merit consideration are what we have termed "joint outputs." Joint outputs of the educational process are those which occur whether or not they are sought and which indeed may be unintended. For example, a possible joint outcome of the educational process is a change in staff morale. Changes in the system inevitably will affect the morale of teachers, administrators, and others. Although changes in staff morale are not often a primary objective of the educational process, virtually any change in the system has potential for affecting staff morale. Joint outcomes of the educational process are analogous to the smoke produced by an industrial plant or the odor produced by a paper mill. It is not the primary objective of a factory or mill to produce smoke or odor, yet these incidental (and often unwanted) outputs may be of great concern. Any analyst who seeks to understand the educational production process must be aware that joint outcomes are likely to be produced and should be sensitive to the potential significance of such outcomes.

FEEDBACK

The fourth major component of the conceptual framework portrayed in Figure 8 is the feedback loop. The feedback component is the system's self-correcting mechanism. Feedback is produced by comparing the system's outputs with its objectives. It should be noted that feedback occurs continuously, whether or not it is planned by the school. For example, if the graduates of a school cannot read as well as they should, parents, employers, and interested citizens will promptly inform the school and expect corrective actions to be taken. It is through planned evaluation of the system's performance (i.e., comparing outputs and objectives) that resource allocations can most effectively be altered or modified to achieve a better match between objectives and results.

Feedback can provide a basis for altering the allocation of resources within the educational system itself or it can result in modifying the resources made available to the system from the external environment. Dissatisfaction with the output of the system may, for example, result in a decision to make more (or less) resources available to a school. Similarly, feedback may result in decisions which alter the nature of the instructional process within a given curricular area by instituting changes in time allocation, grouping procedures, or staffing patterns. Feedback can also alter the aims and priorities established for the system or the controls established to monitor system performance. Thus, the feedback component ties the system together and ensures that it remains dynamic.

IX

IMPLICATIONS FOR RESEARCH ON COST-EFFECTIVENESS IN EDUCATION

Although few would disagree with the statement that the educational process is extraordinarily complex, the implications of this statement for research on cost-effectiveness in education have not yet been fully realized. Our knowledge of the learning process is sketchy. Although there are various theories of learning, none has been validated sufficiently to serve as a reliable basis for prediction. The interaction of the wide variety of variables which bear upon the outcomes of the learning process is not well understood. In fact, even if it were possible to conduct controlled experiments, we do not yet know which variables are most important to control. Much of the research to date has utilized macro-measures of input and output and has focused at the school district, state, or national level. Future research must focus on the individual pupil and should be longitudinal in design. Unless future research focuses on individual pupils, it will be difficult or impossible to answer questions about what instructional procedures, materials, and processes are best for whom and under what conditions.

Laboratory experiments are neither feasible nor practical in cost-effectiveness research. Even if controlled experiments could be performed, the crucial question for educational decision makers is "What happens under school conditions?" It must be recognized that it is difficult to assure either randomness of subjects or precision of treatments when data are gathered under school conditions. Thus, researchers must be reconciled to the fact that data on school input, process, and output will always be somewhat "dirty."

It is also important that attention be directed to those variables which are amenable to control by teachers and administrators. While it is important and useful to know that certain socioeconomic background variables may bear heavily upon a child's performance in school, such variables are generally beyond the control of the school. Variables within the control of administrators and teachers offer more promise in terms of improving cost-effectiveness relationships in education.

The problems of acquiring data on both cost and process variables merit further consideration. Disaggregated data concerning the monetary costs of various school inputs are virtually nonexistent. Few school systems are able to provide data on the cost of operation of individual schools, much less on the fiscal inputs to various curricular programs within a school. It is even difficult to obtain from educational personnel accurate estimates of the time they spend on various tasks. Furthermore, the cost of conducting time and motion studies is prohibitive. The task of obtaining data concerning the attributes of individual pupils has been complicated by recent federal and state legislation restricting access to such information. While the objectives of the legislation are laudable, it does impede the progress of investigators

interested in conducting cost-effectiveness research. Although the problems involved in obtaining data on individual pupils are not insurmountable, the time and cost involved in obtaining such data have been increased substantially.

The problems of obtaining data on school inputs are relatively simple, however, when compared to the problems associated with measuring outputs. Perhaps the most perplexing problem is that general agreement does not exist concerning the priorities which are to be assigned to specific educational objectives. For example, while nearly everyone agrees that schools should turn out "good citizens," it is extraordinarily difficult to obtain consensus on any operational measure of a "good citizen." And even if we could agree on such measures, by the time data are collected and analyzed the educational process is likely to have changed during the interim.

Research on cost-effectiveness conducted on specific curricular programs and products and on alternative educational processes using short-run measures of output holds promise for increasing productivity. However, alternative programs and processes can validly be compared only when their specified objectives are very similar. Since specific (as opposed to general) educational objectives should be established for units no larger than a school district, and preferably no larger than an individual school, cost-effectiveness research should focus at these, not at state or national levels.

Although the difficulties involved in conducting research on school productivity and efficiency should not be underestimated, these difficulties should not deter researchers. Research on productivity and efficiency is a logical and necessary next step in the continuing search for equality of educational opportunity. Only through research adding to our knowledge of the interrelationships and interactions between variables affecting educational outcomes can we hope to achieve greater equality of outcomes for students. Scholars in school finance are now able to design school finance programs which will assure equality of fiscal inputs to school districts and even to individual schools. These technical solutions admittedly are not always politically feasible but the knowledge necessary to develop such solutions exists. Attention must now be directed to achieving greater equality in the outcomes of the educational process. Economic analysis of the educational production system offers a valuable tool to help achieve this end.

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